Service Manual

Liquefied Petroleum Gas (LPG) Fuel System For 1999 and 2000 GM 7.4L Medium Duty Chassis

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Liquefied Petroleum Gas (LPG)
Fuel System
For
1999 and 2000
GM 7.4L Medium Duty Chassis

This manual provides information on the diagnosis, the service procedures, the adjustments and the specifications for the Liquefied Petroleum Gas (LPG) Fuel System as used on the 1999 and 2000 GM 7.4L Medium Duty Chassis. **This manual is a supplement to be used with the 1999 and 2000 GM MD Truck service manual.**

All information, illustrations and specifications in this manual are based on the latest product information available at the time of publication. IMPCO® reserves the right to make changes at any time without notice.

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CONTENTS

Vehicle Application 5
Propane Fuel System Warning 5
General Description 5
- Propane Fuel System 5
- Low Pressure Regulator (LPR) 5
- Fuel Mixer 6
- Alternative Fuel Engine Control Unit (AF ECU) 6
- Low Pressure Lock-off (LPL) 6
- Control Solenoids 6
- Regulator Control Valve (RCV) 6

Diagnostic Information and Procedures 7
- Specifications 7
- Engine Controls Schematic 8
- AF ECU Connector End Views 10
- Alternative Fuels (AF) Powertrain OBD System Check 12
- Malfunction Indicator Lamp Circuit 15
- AF Fuel System Diagnosis 18
- AF Fuel Control System Diagnosis 23
- DTC 14 ECT Sensor Circuit High Voltage 30
- DTC 15 ECT Sensor Circuit Low Voltage 34
- DTC 16 ECT Excessive Time to Closed Loop 37
- DTC 23 IAT Sensor Circuit Low Voltage 41
- DTC 25 IAT Sensor Circuit High Voltage 44
- DTC 31 ETC System Fault 48
- DTC 34 MAP Sensor Circuit Low Voltage 50
- DTC 36 MAF Sensor Circuit Low Frequency 54
- DTC 37 MAF Sensor Circuit High Frequency 58
- DTC 41 CKP Sensor Circuit Performance 62
- DTC 42 HO2S Insufficient Activity Bank 1 Sensor 1 65
- DTC 44 HO2S Circuit Low Voltage Bank 1 Sensor 1 70
- DTC 45 HO2S Circuit High Voltage Bank 1 Sensor 1 74
- DTC 58 AF ECU Internal Failure 78
- DTC 63 HO2S Insufficient Activity Bank 2 Sensor 1 79
- DTC 64 HO2S Circuit Low Voltage Bank 2 Sensor 1 84
- DTC 65 HO2S Circuit High Voltage Bank 2 Sensor 1 88

Symptom Dignosis 92
- Important Preliminary Checks 92
- Intermittents 93
- Hard Start 94
- Cuts Outs, Misses 96
- Hesitation, Sag, Stumble 97
- Backfire 98
- Lack of Power, Sluggishness, or Sponginess 99
- Poor Fuel Economy 101
- Rough, Unstable, or Incorrect Idle, Stalling 103
- Surges/Chuggles 106

Repair Instructions 108
- Propane Fuel System Pressure Relief 108
- Propane Fuel System Leak Test 108
- Propane Fuel Filter Replacement 108
- Low Pressure Lock-off (LPL) Replacement (Underbody) 108
- Low Pressure Regulator (LPR) Replacement 108
- Low Pressure Lock-off (LPL) Replacement (Underhood) 110
- Fuel Mixer Cover Replacement 110
- Electronic Throttle Control (ETC) Solenoid Replacement 111
- Fuel Control Solenoid (FCS) Replacement 111
- Idle Control Solenoid (ICS) Replacement 112
- Regulator Control Valve (RCV) Replacement 112

Fuel Mixer Replacement....112
Fuel Mixer Outlet Elbow Replacement....112
Engine Control Unit (ECU) Replacement....112
Propane Fuel System Inspection....113
Technical Specifications....113

VEHICLE APPLICATION

The IMPCO® propane system is designed for the 1999 and 2000 GM Medium Duty Chassis with the 7.4L V 8.

PROPANE FUEL SYSTEM CAUTIONS

CAUTION: Do not smoke, carry lighted tobacco, or use a lighted flame of any type when working on or near any fuel related component. Highly flammable air-fuel mixtures may be present and can be ignited causing personal injury.

CAUTION: Do not allow propane to contact the skin. Propane is stored in the fuel tank as a liquid. When propane contacts the atmosphere, it immediately expands into a gas, resulting in refrigeration that can cause severe burns.

CAUTION: Do not allow propane to accumulate in areas below ground level such as in a service pit or under an alignment rack. Propane is heavier than air and can displace oxygen, creating a dangerous condition.

DESCRIPTION AND OPERATION

PROPANE FUEL SYSTEM

The primary components of the propane fuel system are the low pressure regulator, fuel mixer, electric lock-off solenoids and engine control unit (ECU). The system operates at pressures up to 312 psi.

Propane is delivered from the tank through the filter / underbody low pressure lock-off (LPL) assembly to the underhood LPL. Both lock-offs are activated by the fuel pump control circuit. The lock-offs, which are normally closed, open only when the engine is cranking or running. Fuel passes through the underhood lock-off solenoid to the fuel inlet on the LPR.

Propane enters the primary chamber of the LPR through the primary jet where the pressure is reduced to approximately 1-2 psi (1999) or approximately 2-3 psi (2000). This fuel is then vaporized as it passes through the heat exchanger located in the center of the regulator.

During normal engine operation, the fuel is drawn from the secondary chamber of the regulator by the vacuum created as the air passes through the fuel mixer. This pressure drop is most commonly referred to as air valve vacuum. As the air valve vacuum increases or decreases, the amount of fuel drawn from the secondary chamber will increase or decrease. In the fuel mixer, the propane vapor is combined with air to form a combustible air/fuel mixture.

The fuel system is controlled by the Alternative Fuels Engine Control Unit (AF ECU). The AF ECU receives input from various engine sensors to determine the amount of fuel necessary to maintain a precise air/fuel mixture across the entire engine operational range. The AF ECU then sends a command to the fuel control solenoid (FCS) to meter the appropriate quantity of fuel. The FCS meters the fuel flow by changing the pressure on the regulator diaphragm from atmosphere to vacuum. The system will also automatically sense and compensate for changes in altitude.

LOW PRESSURE REGULATOR (LPR)

The IMPCO® Model E low pressure regulator (LPR) is a combined pressure regulator and vaporizer. The regulator is a negative pressure two-stage configuration that is closed when the engine is not running. When the engine is cranking or running, a partial vacuum is created in the fuel line to the regulator. This opens the regulator, permitting fuel to flow to the fuel mixer.

The regulator receives liquid fuel at tank pressure. The pressure is reduced in two stages to slightly less than atmospheric. In the first stage, the pressure is reduced to approximately 1-2 psi (1999) or approximately 2-3 psi (2000). Also during this stage, the liquid fuel is vaporized by heating the base of the LPR with engine coolant. A sponge located in the primary chamber absorbs any liquid fuel and prevents it from entering the secondary chamber. In the second stage, the vaporized fuel is drawn into the secondary chamber where the pressure is reduced to approximately negative 1.5” of water column.

FUEL MIXER

The IMPCO® Model 425 fuel mixer is an air-fuel metering device and is completely self contained. It requires no linkage or idle vacuum line to the intake manifold. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load.

The vacuum applied to the air valve, working against a spring located on top of the valve, correctly positions the air valve to meter the proper amount of fuel for any given engine speed and load. The pressure drop that is controlled by the air valve spring provides the force to draw fuel into the air stream. The upward movement of the diaphragm controls the fuel flow in the venturi air valve.

A pressure drop under the air valve of approximately 0.2 psi (6" water column) of pressure is required to lift the air valve off its seat. Approximately 0.5 psi (13.8" water column) lifts the valve to the top of its travel in full open position. Lowered pressure communicated to the top of the diaphragm varies with engine speed and position of throttle valve opening. The air valve assembly measures the air flow into the engine by moving precisely in response to the demands of the engine and throttle valve position.

The controlled pressure drop of 0.2 to 0.5 psi (6" to 13.8" water column) set up by the metering spring provides the signal or force necessary to draw fuel into the air stream within the carburetor. The gas metering valve is attached to the air valve assembly and is shaped to admit the correct amount of fuel from the gas jet to mix with incoming air at any opening of the air valve.

ALTERNATIVE FUEL ENGINE CONTROL UNIT (AF ECU)

The alternative fuel engine control unit (AF ECU) controls the propane fuel system. The AF ECU monitors various engine and vehicle functions to provide the correct amount of fuel under all operating conditions. This provides excellent driveability and fuel economy while maintaining reduced exhaust emission levels.

LOW PRESSURE LOCK-OFF (LPL)

The electric low pressure lock-off solenoids provide electronic fuel shut-off for pressures up to 312 psi. It is a closed solenoid operated lock-off with a 1/4" diameter fuel orifice. If the lock-off fails, it is designed to fail in the closed position. The solenoid has a high temperature coil and is both UL and CGA approved.

CONTROL SOLENOIDS

FUEL CONTROL SOLENOID (FCS)
An electrically actuated control solenoid used to trim fuel mixtures by controlling the pressure on top of the regulators secondary diaphragm. Controlled by the ECU, the solenoid translates a duty cycle into a regulated vacuum signal. The fuel control solenoid meters air valve vacuum to the regulator to lean fuel mixtures or references atmospheric pressure to richen fuel mixtures.

IDLE CONTROL SOLENOID (ICS)
An electrically actuated control solenoid used to meter fuel to the engine during idle and low speed operation. Controlled by the ECU, the idle control solenoid will be shut-off after certain engine speed and load conditions are met.

ELECTRONIC THROTTLE CONTROL (ETC) SOLENOID
An electrically actuated control solenoid used to control the mixer air valve. If the AF ECU detects a Throttle Actuator Control (TAC) fault, the ETC solenoid vents the air valve vacuum to atmosphere, causing the air valve to close and forcing an idle condition.

REGULATOR CONTROL VALVE (RCV)

The regulator control valve (RCV) is mounted on the regulator cover. The RCV is a one way check valve that opens at 10-12” of water column and permits quick response of the secondary diaphragm during wide open throttle operation.

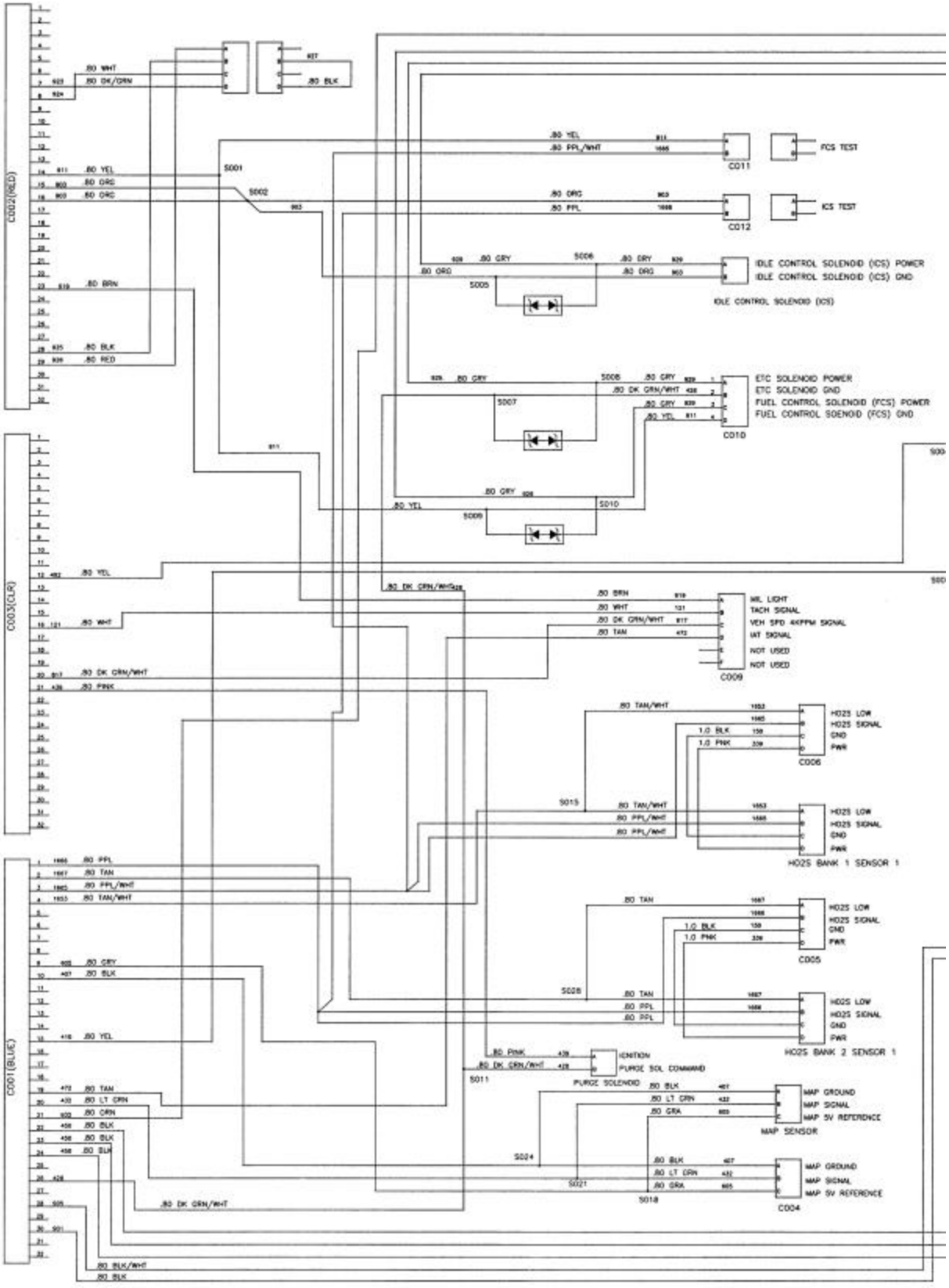
DIAGNOSTIC INFORMATION AND PROCEDURES

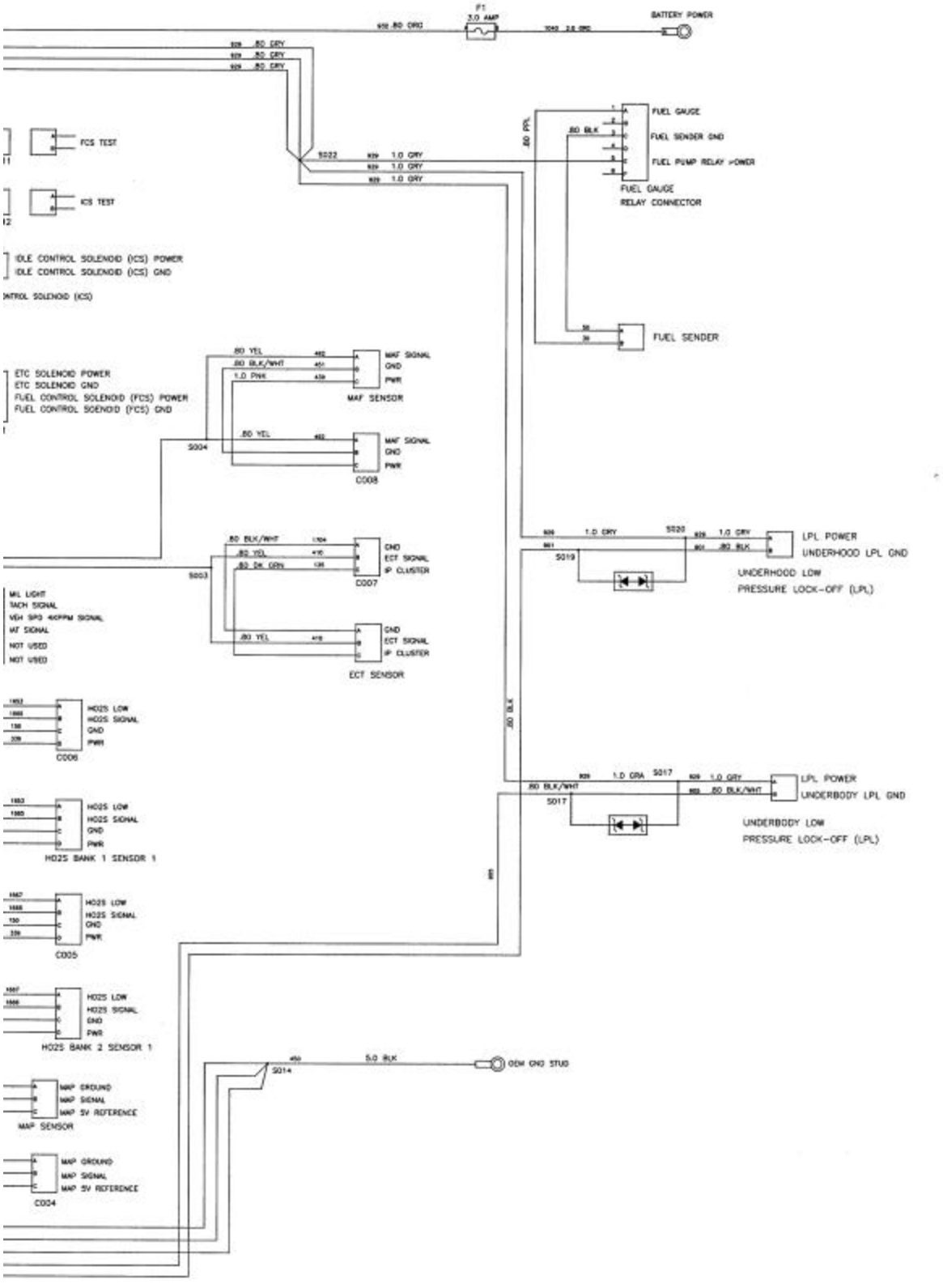
Specifications

Temperature vs Resistance

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
–5	23	12300
–10	14	16180
–15	5	21450
–20	–4	28680
–30	–22	52700
–40	–40	100700

Engine Controls Schematic




F1
3.0 AMP
BATTERY POWER
.80 ORG
.80 GRY
.80 GRY
.80 GRY
FCS TEST
ICS TEST
IDLE CONTROL SOLENOID (ICS) POWER
IDLE CONTROL SOLENOID (ICS) GND
ETC SOLENOID POWER
ETC SOLENOID GND
FUEL CONTROL SOLENOID (FCS) POWER
FUEL CONTROL SOLENOID (FCS) GND
MIL LIGHT
TACH SIGNAL
VSH SPD 4X/PPM SIGNAL
MT SIGNAL
NOT USED
NOT USED
S022
1.0 GRY
1.0 GRY
1.0 GRY
.80 PPL
.80 BLK
FUEL GAUGE
FUEL SENDER GND
FUEL PUMP RELAY POWER
FUEL GAUGE
RELAY CONNECTOR
FUEL SENDER
.80 YEL
.80 BLK/WHT
1.0 PNK
MAF SIGNAL
GND
PWR
MAF SENSOR
S004
C008
.80 BLK/WHT
.80 YEL
.80 DK GRN
GND
ECT SIGNAL
IP CLUSTER
S003
C007
ECT SENSOR
HO2S LOW
HO2S SIGNAL
GND
PWR
C006
HO2S BANK 1 SENSOR 1
C005
HO2S BANK 2 SENSOR 1
MAP GROUND
MAP SIGNAL
MAP 5V REFERENCE
MAP SENSOR
C004
S020
1.0 GRY
.80 BLK
S019
LPL POWER
UNDERHOOD LPL GND
UNDERHOOD LOW
PRESSURE LOCK-OFF (LPL)
.80 BLK
S017
1.0 GRA
1.0 GRY
.80 BLK/WHT
LPL POWER
UNDERBODY LPL GND
UNDERBODY LOW
PRESSURE LOCK-OFF (LPL)
S014
5.0 BLK
OEM GND STUD

AF ECU Connector End Views

Blue C001 32 Pin Connector End View

Connector Part Information		· 12129025 • C001 32 Pin Connector (Blue)	
Pin	**Wire Color**	**Circuit No.**	**Function**
1	PPL	1666	HO2S B2 S1 Signal
2	TAN	1667	HO2S B2 S1 Low
3	PPL/WHT	1665	HO2S B1 S1 Signal
4	TAN/WHT	1653	HO2S B1 S1 Low
5-8	-	-	Not Used
9	GRY	605	MAP 5V Reference
10	BLK	407	MAP Sensor Ground
11-14	-	-	Not Used
15	YEL	410	ECT Sensor Signal
16-18	-	-	Not Used
19	TAN	472	IAT Sensor Signal
20	LT GRN	432	MAP Sensor Signal
21	ORN	932	12V Battery Power
22	BLK	450	Ground
23	BLK	450	Ground
24	BLK	450	Ground
25	-	-	Not Used
26	DK GRN/ WHT	428	ETC Solenoid Ground
27	-	-	Not Used
28	BLK/WHT	905	Underbody LPL Ground
29	-	-	Not Used
30	BLK	901	Underhood LPL Ground
31-32	-	-	Not Used

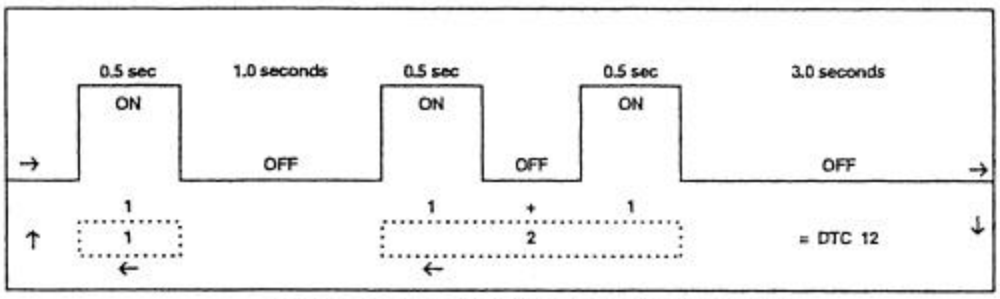
Red C002 32 Pin Connector End View

Connector Part Information		· 12129025 • C002 32 Pin Connector (Red)	
Pin	**Wire Color**	**Circuit No.**	**Function**
1-6	-	-	Not Used
7	DK/GRN	923	Not Used
8	WHT	924	Not Used
9-13	-	-	Not Used
14	YEL	911	**FCS Ground**
15	ORG	903	**ICS Ground**
16	ORG	903	ICS Ground
17-22	-	-	Not Used
23	BRN	919	MIL Output
24-27	-	-	Not Used
28	BLK	925	Not Used
29	RED	926	Not Used
30-32	-	-	Not Used

Clear C003 32 Pin Connector End View

Connector Part Information		· 12129025 • C002 32 Pin Connector (Red)	
Pin	**Wire Color**	**Circuit No.**	**Function**
1-11	-	-	Not Used
12	YEL	492	MAF Sensor Signal
13-15	-	-	Not Used
16	WHT	121	TACH Input Signal
17-19	-	-	Not Used
20	DK GRN/WHT	817	Vehicle Speed Sensor Input Signal
21	PNK	439	Ignition Power
22-32	-	-	Not Used

Alternative Fuels (AF) Powertrain OBD System Check



The above chart is example of the timing sequence to flash DTC 12

Circuit Description

The On-Board Diagnostic (OBD) System Check is an organized approach to identifying a problem created by a control module system malfunction. The OBD is the starting point for any driveability concern diagnosis. The OBD directs the service technician to the next logical step in diagnosing the concern. This system check will address possible faults in two separate control module systems. ***To avoid unnecessary diagnostic time, follow the system check carefully.***

Perform this check **ONLY** if there is a driveability complaint or if you have been sent to this system check from another section in the service information.

Understanding the table properly reduces the diagnostic time. Proper use of the OBD helps prevent the unnecessary replacement of good parts.

Diagnostic Aids

Important: Do not clear DTCs unless directed by a diagnostic procedure. Clearing the DTCs will also clear valuable Freeze Frame and Failure Records data.

Inspect all related wiring and connections including the connections at the PCM. These may cause an intermittent malfunction.

Check any circuitry that is suspected of causing an intermittent condition for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness
- Corrosion

Test Description

The numbers below refer to the step numbers on the diagnostic table.

1. This step isolates if the customer complaint is a MIL or a driveability problem with no MIL.
2. When the ignition switch is turned ON, the scan tool should display serial data. This step determines if the PCM is powered up.
3. Refer to DTC Identification for a list of valid DTCs. A faulty scan tool, PCM Programming or PCM may result in an invalid DTC.
4. This step enables the AF ECU DTC display mode.
5. DTCs are displayed in ascending order. Each DTC is flashed three (3) times prior to displaying the next available DTC. When all stored DTCs have been displayed, the AF ECU will begin the cycle again at DTC 12 until the AF ECU is returned to normal operation.
6. This step will clear all AF ECU DTCs and reset the fuel trim to its initial value.
7. This step verifies that the engine will start.
8. Comparison of an actual control system data with the Typical Scan Tool Data Values is a quick check to determine if any parameter is not within limits. A base engine problem (i.e., advanced cam timing) may substantially alter sensor values.

Alternative Fuel (AF) Powertrain OBD System Check

Step	Action	Value(s)	Yes	No
1	**Important:** Check for applicable service bulletins before proceeding with this test. Perform this test only if there is a driveability complaint or if you have been sent to this table from another section in the service information. **Important:** Do not clear DTCs unless instructed by this diagnostic. 1. Turn off the ignition. 2. Connect the scan tool. 3. Turn ON the ignition leaving the engine OFF. 4. Observe the MIL. Does the MIL illuminate for 2 seconds then turn off?	—	Go to *Step 2*	Go to *Malfunction Indicator Lamp Circuit Check* in the GM MD Service Manual
2	Does the scan tool display the PCM data?	—	Go to *Step 3*	Go to *Data Link Connector Diagnosis* in the GM MD Service Manual
3	Observe the DTC information. If the DTC status Last Test Failed, Test Failed, Test Failed This Ignition, MIL Request, or History DTC are set, save the DTC Freeze Frame and the Failure Records information as necessary, using the scan tool. Were any of these DTCs set?	—	Go to the Applicable DTC Table in the GM MD Service Manual	Go to *Step 4*
4	Turn the ignition switch from OFF to RUN 3 times within 10 seconds. Does the MIL begin to flash?	—	Go to *Step 5*	
5	Observe and record any DTCs. All DTCs will be flashed 3 times before proceeding to the next DTC. All codes have been displayed when DTC 12 is flashed again. Are any DTCs set?	—	Go to *Step 6*	Go to *Driveability Symptoms*

Step	Action	Value(s)	Yes	No
6	Before going to the applicable DTC table, while in AF ECU DTC retrieval mode turn ignition from OFF to ON 3 additional times and wait 10 seconds after the MIL turns off before turning ignition off. This will clear all AF ECU DTCs and reset fuel trim. **Important**: If the ignition switch is not cycled OFF for 10 seconds after clearing any DTC(s) and the vehicle is started, the AF ECU OBD system will be disabled for that key cycle. Is the action complete?	—	Go to the Applicable DTC Table	—
7	Crank the engine for 10 seconds or until the engine starts. Does the engine start?	—	Go to *Step 8*	Go to *Engine Cranks but Does Not Run* in the GM MD Service Manual
8	Compare the scan tool engine data with the Typical Scan Tool Data Values. Are values normal or within typical range?	—	Go to *Driveability Symptoms*	Go to the indicated Component System checks

Malfunction Indicator Lamp Circuit

Circuit Description

When the vehicle's operator initially turns on the ignition, the MIL will illuminate for 2 seconds. If no Diagnostic Trouble Codes (DTCs) are stored, the Powertrain Control Module (PCM) turns off the MIL. The PCM controls the MIL providing a ground path through the MIL control circuit in order to turn on the MIL. The MIL control circuit is routed through the Alternative Fuel Electronic Control Unit (AF ECU) to give the ECU the ability to turn on the MIL if an AF system DTC is set.

Diagnostic Aids

An open gauge fuse will cause the entire IP cluster to be inoperative.
Check any circuitry that is suspected of causing an intermittent condition for the following conditions:

- Backed out terminals.
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal wiring connections
- Physical damage to the wiring harness

Test Description

The numbers below refer to the step numbers on the diagnostic table.

1. The powertrain OBD System Check prompts the technician to complete some basic checks and store the freeze frame and failure records data with the scan tool if applicable. This creates an electronic copy of the data when the fault occurred. The information is then stored in the scan tool for later reference.
3. If the MIL illuminates but does NOT turn-off after 2 seconds, the PCM may have incorrect software.
4. If the engine fails to start and the MIL is inoperative, then the fault can be isolated to the PCM ignition feed, the battery feed, a poor PCM ground at the engine block, or the PCM.
5. A MIL that responds correctly to the scan tool commands indicates that a PCM fault is not present at this time or that the condition has been corrected.
6. A MIL that responds correctly to the AF ECU DTC retrieval sequence indicates that the fault is not present or that the condition has been corrected.

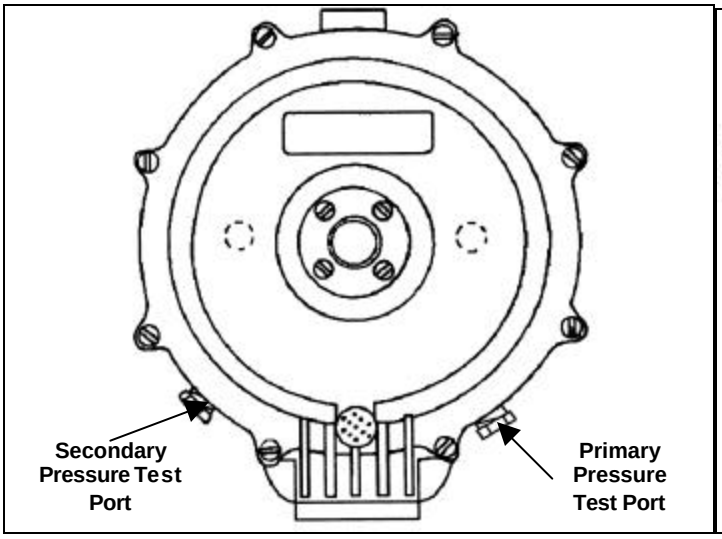
Malfunction Indicator Lamp Circuit

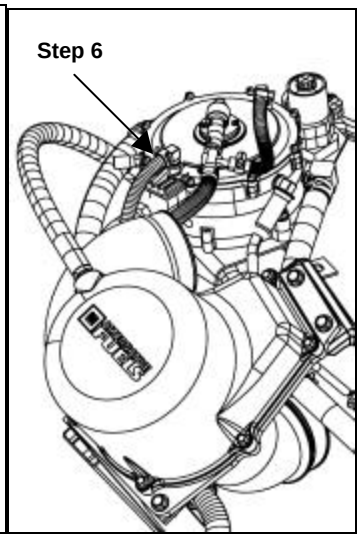
Step	Action	Value(s)	Yes	No
1	Were you sent here by the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check?	—	Go to *Step 3*	Go to *Step 2*
2	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 3*	**Go to *AF Powertrain OBD System Check***
3	1. Turn the engine OFF for 15 seconds. 2. Turn the ignition ON, engine OFF. Does the MIL illuminate for 2 seconds and then turn off?	—	Go to *Step 6*	Go to *Step 4*
4	Attempt to start the engine. Does the engine start?	—	Go to *Step 5*	Go to *Step 13*
5	1. Connect a scan tool. 2. Command the MIL on and off. Does the mil operate as commanded?	—	**Go to *Step 6***	**Go to *Step 7***

Step	Action	Value(s)	Yes	No
6	1. Turn the ignition OFF for 10 seconds. 2. Turn the ignition switch from the OFF to RUN position 3 times within 10 seconds. Does the MIL begin to flash?	—	Go to *Step 18*	Go to *Step 8*
7	1. Disconnect ECU connector C002. 2. Using a scan tool, command the MIL on and off. Does the MIL operate as commanded?	—	Go to *Step 14*	Go to *Step 10*
8	1. Disconnect ECU connector C002. 2. Check for continuity of the MIL circuit between connectors C002 and C009. Is there continuity?	—	Go to *Step 9*	Go to *Step 11*
9	Is the MIL continuously illuminated?	—	Go to *Step 12*	Go to *Step 14*
10	1. Disconnect connector C009. 2. Using a scan tool, command the MIL on and off. Does the MIL operate as commanded?	—	Go to *Step 11*	Go to *MIL Circuit Diagnosis* in the GM MD Service Manual
11	The circuit between connectors C009 and C002 is shorted to power or ground. Repair the circuit as necessary. Is the action complete?	—	Go to *Step 18*	—
12	Repair the short to ground in the MIL control circuit. Is the action complete?	—	Go to *Step 18*	—
13	1. Check the PCM ignition power, battery power and ground circuits for shorts and opens. 2. Check the ECU ignition power, battery power and ground circuits for shorts and opens. Was as problem found?	—	Go to *Step 17*	Go to Diagnostic by Symptom *Hard Start*
14	Check for faulty ECU connections. Was a problem found?	—	Go to *Step 17*	Go to *Step 15*
15	Check for faulty connections at connector C009. Was a problem found?	—	Go to *Step 17*	Go to *Step 16*
16	Replace the ECU. Is the action complete?	—	Go to *Step 18*	—
17	Repair as necessary. Is the action complete?	—	Go to *Step 18*	—

Step	Action	Value(s)	Yes	No
18	1. Allow engine to idle until normal operating temperature is reached. 2. Check if there are any DTCs set. Are any DTCs displayed that have not been diagnosed?	—	Go to the Applicable DTC Table	System OK

AF Fuel System Diagnosis





Fuel System Description

The alternative fuel engine control unit (AF ECU) receives information from various engine sensors in order to control the operation of the fuel and idle control valves and the low pressure lock-off (LPL) solenoids. The LPL solenoids prevent fuel flow unless the engine is cranking or running. LPG is stored in the tank and delivered under pressure to the system as a liquid. During key on, the underbody LPL receives a two (2) second prime pulse. When the key is ON and the engine running, LPG flows from the tank through the underbody LPL, fuel filter and fuel lines at pressures up to 2151 kPa (312 psi). The fuel then flows to the underhood LPL and to the low pressure regulator (LPR) where the fuel is vaporized and the pressure reduced in two stages. The first stage reduces the pressure to approximately 1 to 2 psi (1999) or to approximately 2-3 psi (2000). The second stage reduces the pressure to approximately negative 1.5" w.c. The fuel is then drawn from the secondary chamber of the LPR by the vacuum generated by air flowing through the mixer. This vacuum signal is also used to generate lift for the mixer air valve. This vacuum signal is most commonly referred to as air valve vacuum. In the mixer, the fuel mixes with the air entering the engine. This air/fuel mixture is then drawn into the engine for combustion.

Diagnostic Aids

This procedure is intended to diagnose a vehicle operating on LPG. If the vehicle will not continue to run on LPG, refer to *Hard Start* for preliminary checks. Before proceeding with this procedure, verify that the vehicle has a sufficient quantity of fuel and that liquid fuel is being delivered to the LPR. Also, ensure that the manual shut off valve on the LPG tank is fully opened and that the excess flow valve has not been activated.

Tools Required:

- DVOM (GM J 39200, Fluke 88 or equivalent).

Duty Cycle Monitoring Tool

- IMPCO Fuel System Analyzer (FSA), or DVOM (GM J 39200, Fluke 88 or equivalent).

Diagnostic Scan Tool

- GM Tech 2 or equivalent.

Pressure Gauges

- Water Column Gauge / Manometer (GM 7333-6 or equivalent).
- 0-5 PSI Gauge (GM 42580 or equivalent).

Test Description

The numbers below refer to step numbers on the diagnostic table.

5. This step will determine if the fuel control solenoid (FCS) and fuel supply system are functioning properly. The vacuum on the secondary test port will be approximately –1.0" to 2.0" w.c. If the vehicle has a hard start or poor idle, check for proper operation of the idle control solenoid (ICS).
6. This step checks the base mechanical LPR output pressure by disabling all fuel control devices.

9. This step checks for proper air valve operation.

19. This determines if fuel is available from the fuel tank supply system.

AF Fuel System Diagnosis

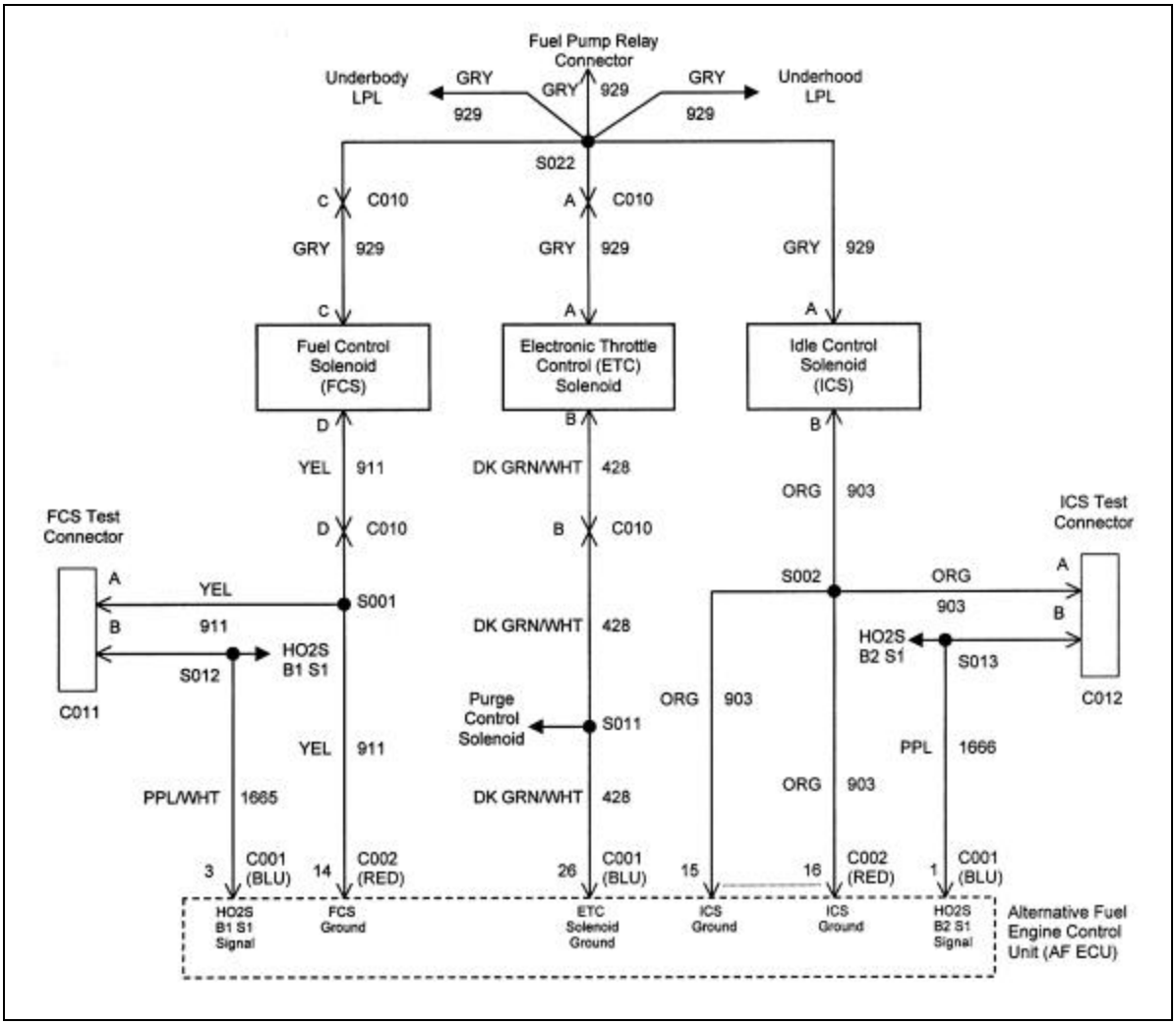
Step	Action	Value(s)	Yes	No
1	Were you referred to this procedure by a DTC diagnostic chart?	—	Go to *Step 3*	Go to *Step 2*
2	Perform the AF On Board Diagnostic (OBD) System Check. Are any DTCs present in the AF ECU?	—	Go to the applicable DTC Table	Go to *Step 3*
3	Verify that the LPG fuel tank has a minimum of 1/4 tank of fuel. Does the vehicle have fuel?	—	Go to *Step 4*	—
4	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Start the engine and allow it to reach operating temperature. Does the engine start and run?	—	Go to *Step 5*	Go to *Step 8*
5	With the engine at 2500 rpm, observe the pressure reading for the LPR secondary pressure. Does the fuel pressure fluctuate rhythmically outside the specified range?	-1.25” to -1.75” w.c.	Go to *Step 29*	Go to *Step 6*
6	1. Remove the vacuum hose from the LPR fitting. 2. Disconnect the ICS electrical connector. **Note:** This action may cause a DTC to be set by the PCM or AF ECU 3. Observe the pressure reading on the secondary test port. Is the fuel pressure within the specified value?	-1.0” to -2.0” w.c.	Go to *AF Fuel Control System Diagnosis*	Go to *Step 7*
7	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the vacuum hoses in the mixer area for proper connection and condition. 3. Inspect the fuel hose connection between the LPR and mixer assembly for damage or leakage. Was a problem found and corrected?	—	Go to *Step 30*	Go to *Step 26*
8	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR secondary pressure. Does the fuel pressure indicate a vacuum is present?	—	Go to *Step 12*	Go to *Step 9*

Step	Action	Value(s)	Yes	No
9	1. Remove the bonnet from the mixer assembly. 2. Observe the air valve for movement while the engine is cranking. **Note:** Movement of the air valve will be minimal at cranking speeds. Does the air valve move when the engine is cranked?	—	Go to *Step 11*	Go to *Step 10*
10	1. Inspect the air intake stream between the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses in the mixer area for proper connection and condition. Was a problem found and repaired?	—	Go to *Step 30*	Go to *Step 28*
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	—	Go to *Step 30*	Go to *Step 22*
12	1. Connect a 0-5 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is fuel pressure present above the specified value?	1 psi (1999) or 4 psi (2000)	Go to *Step 26*	Go to *Step 13*
13	1. Turn OFF the ignition. 2. Disconnect the underhood LPL connector. 3. Install a test light between the pins of the LPL connector. 4. Crank the engine. The test light should illuminate. Does the test light illuminate?	—	Go to *Step 14*	Go to *Step 16*
14	Using a DVOM, check the resistance of the low pressure lock-off (LPL). Is the resistance within the specified range?	6.2 Ω - 10 Ω	Go to *Step 15*	Go to *Step 27*
15	1. Turn the ignition OFF. 2. Close the manual shut-off valve on the LPG tank. **CAUTION: When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area.** 3. Loosen the fuel inlet hose fitting at the inlet of the underhood LPL. Was fuel present when the fitting was loosened?	—	Go to *Step 27*	Go to *Step 17*

Step	Action	Value(s)	Yes	No
16	1. Turn OFF the ignition. 2. Connect the test light to chassis ground and probe pin A of the LPL connector. 3. Crank the engine. The test light should illuminate. Does the test light illuminate?	—	Go to *Step 24*	Go to *Step 25*
17	1. Disconnect the underbody LPL connector. 2. Install a test light between the pins of the LPL connector. 3. Turn the ignition ON. The test light should illuminate for 2 seconds. Does the test light illuminate?	—	Go to *Step 18*	Go to *Step 23*
18	Using a DVOM, check the resistance of the underbody LPL. Is the resistance within the specified range?	6.2 Ω - 10 Ω	Go to *Step 19*	Go to *Step 27*
19	1. Turn the ignition OFF. 2. Close the manual shut-off valve on the LPG tank. **CAUTION: When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area.** 3. Loosen the fuel inlet hose fitting at the inlet of the underhood LPL. Was fuel present when the fitting was loosened?	—	Go to *Step 21*	Go to *Step 20*
20	The fuel supply system or hoses are plugged or restricted, locate and repair the problem. Is the action complete?	—	Go to *Step 30*	—
21	1. Remove the underbody LPL and filter assembly. 2. Remove the filter from the LPL assembly. 3. Empty the contents of the inlet side of the fuel filter onto a clean surface. 4. Inspect the contents of the fuel filter for an excessive amount of foreign material or water. If necessary, locate and repair the source of contamination. Is the action complete?	—	Go to *Step 22*	—
22	Replace the fuel filter. Refer to *Fuel Filter Replacement.* Is the action complete?	—	Go to *Step 30*	—

Step	Action	Value(s)	Yes	No
23	1. Turn OFF the ignition. 2. Connect the test light to chassis ground and probe pin A of the LPL connector. 3. Crank the engine. The test light should illuminate. Does the test light illuminate?	—	Go to *Step 24*	Go to *Step 25*
24	Repair the open in the lock-off ground circuit. Refer to *Wiring Repairs* in the *GM MD Service Manual*. Is the action complete?	—	Go to *Step 30*	—
25	Repair the open in the lock-off power circuit. Refer to *Wiring Repairs* in the *GM MD Service Manual*. Is the action complete?	—	Go to *Step 30*	—
26	Replace the low pressure regulator (LPR). Refer to *Low Pressure Regulator Replacement*. Is the action complete?	—	Go to *Step 30*	—
27	Replace the lock-off. Refer to *Low Pressure Lock-off (LPL) Replacement*. Is the action complete?	—	Go to *Step 30*	—
28	Replace the mixer assembly. Refer to *Fuel Mixer Replacement*. Is the action complete?	—	Go to *Step 30*	—
29	The fuel supply system is operating normally, if a failure of the fuel control solenoids is suspected. Refer to *AF Fuel Control System Diagnosis.* 1. Install the test plug in the LPR secondary chamber. 2. If you were sent to this routine by another diagnostic chart, return to the previous diagnostic procedure. Is the action complete?	—	System OK	—
30	1. Disconnect all test equipment 2. Install the primary and secondary test port plugs. 3. Start the engine. 4. Using SNOOP® or equivalent, leak check the test port plugs. Is the action complete?	—	System OK	—

AF Fuel Control System Diagnosis



Fuel Control System Components

The main components of the fuel control system are:

- The alternative fuel engine control unit (AF ECU)
- The low pressure regulator (LPR)
- The regulator control valve (RCV)
- The fuel mixer
- The Fuel Control Solenoid (FCS)
- The Idle Control Solenoid (ICS)
- The ETC Solenoid

Fuel Control System Operation

The AF ECU receives information from various engine sensors in order to control the fuel and idle control valves to maintain closed loop operation. During normal operation the ECU commands a duty cycle to the fuel control solenoid (FCS). The FCS modulates air valve vacuum and atmospheric pressure on top of the secondary diaphragm of the LPR. By controlling the pressure on top of the LPR secondary diaphragm, the ECU can control the output pressure and fuel flow to the mixer. A high FCS duty cycle means the ECU is issuing a lean command to control a rich condition. A low FCS duty cycle means the ECU is issuing a rich command to control a lean condition.

At idle and low speeds the ECU will use the idle control solenoid (ICS) to maintain closed loop operation. The ICS supplies fuel (from the LPR secondary chamber) below the mixer directly into the air stream. For 1999 vehicles, the ECU will command a 50% duty cycle to the ICS until airflow reaches approximately 25 g/s. For 2000 vehicles, the ECU will command a 25%-75% duty cycle to the ICS until airflow reaches approximately 100 g/s.

The regulator control calve (RCV) is a normally closed vent-valve located on top of the LPR. During idle and normal driving conditions, the RCV is closed. This allows the FCS to control the pressure on top of the LPR secondary diaphragm. During sudden throttle changes, the RCV opens to vent the vacuum on top of the secondary diaphragm of the LPR, which allows faster LPR output pressure response.

The ETC solenoid accommodates a reduced power mode command from the PCM. This is accomplished by venting the vacuum on top of the air valve diaphragm to atmosphere. With atmospheric pressure, the air valve will be lowered to the idle position in the mixer and restrict the airflow to reduce power. The ETC solenoid is activated under normal conditions.

ETC Fault Mode Operation

If a PCM Throttle Actuator Control (TAC) DTC (P1514, P1515, P1516, or P1518) is detected by the AF ECU, it will set DTC 31 and enter ETC Fault Mode. In this mode, the PCM issues a command to de-energize the ETC solenoid. The air valve vacuum in the mixer is vented to atmosphere, causing the air valve to close and reduce airflow through the mixer (to a default limit value 6 g/s – 9 g/s). This forces an idle condition. The AF ECU commands the idle control solenoid (ICS) to fuel the engine and maintain fuel control.

Diagnostic Aids

Always diagnose any PCM or ECU codes that are present before beginning this diagnostic procedure. Refer to *Important Preliminary checks* and *Symptom Diagnosis Charts* before attempting to diagnose the AF fuel control system. If the vehicle will not continue to run refer to *Hard Start* for preliminary checks. Before proceeding with this procedure, verify that the *AF Fuel System Diagnosis* has been performed.
Check for the following conditions:

- Loose, cracked or kinked vacuum hoses.
- Poor connection or a damaged harness to the AF ECU, FCS and ICS.
- Poor AF ECU engine block ground.
- Sticking mixer air valve.
- Intake air leak between mixer and throttle body.
- Faulty low pressure regulator (LPR).
- Exhaust leaks.
- Fuel contamination.

Tools Required:
- DVOM (GM J 39200, Fluke 88 or equivalent).

Duty Cycle Monitoring Tool
- IMPCO Fuel System Analyzer (FSA), or DVOM (GM J 39200, Fluke 88 or equivalent).

Diagnostic Scan Tool
- GM Tech 2 or equivalent.

Pressure Gauges
- Water Column Gauge / Manometer (GM 7333-6 or equivalent).
- 0-5 PSI Gauge (GM 42580 or equivalent).

Test Description

The numbers below refer to step numbers on the diagnostic table.

4. This test determines proper fuel control system authority at idle.
6. This test determines if there is a ETC system problem.
7. This test determines proper fuel control system operation at 2500 RPM.
10. This determines if there is an RCV problem at idle.
14. This determines if there is an RCV problem at 2500 RPM.

AF Fuel Control System Diagnosis

Step	Action	Value(s)	Yes	No
1	Were you referred to this procedure by another diagnostic chart?	—	Go to *Step 3*	Go to *Step 2*
2	Perform the AF On-Board Diagnostic (OBD) System Check. Are any DTCs present in the AF ECU?	—	Go to the applicable DTC Table	Go to *Step 3*
3	Has the AF Fuel System Diagnosis been performed?	—	Go to *Step 4*	Go to *AF Fuel System Diagnosis*
4	1. Connect a scan tool. 2. Start the engine and allow it to reach operating temperature. 3. Connect a duty cycle monitoring tool at C011 test connector as follows: **FSA:** Yellow clip to pin A (YEL). Green clip to pin B (PPL/WHT). Red clip to 12V power. Black clip to ground. **DVOM:** Set for duty cycle percentage and connect between pin A (YEL) and a good ground. 4. With the engine idling observe the duty cycle reading of the FCS. Is the FCS duty cycle within the specified range?	25% to 75%	Go to *Step 6*	Go to *Step 5*
5	Is the FCS duty cycle below the specified value?	25%	Go to *Step 8*	Go to *Step 10*
6	Will the engine rev to 2500 RPM?	—	Go to *Step 7*	Go to *Step 13*
7	1. Observe the scan tool MAF reading. 2. Raise the engine speed to approximately 2500 RPM or greater than 28 g/s MAF. 3. Observe the duty cycle reading of the FCS. Is the FCS duty cycle within the specified range?	25% to 75%	Go to *Step 34*	Go to *Step 14*

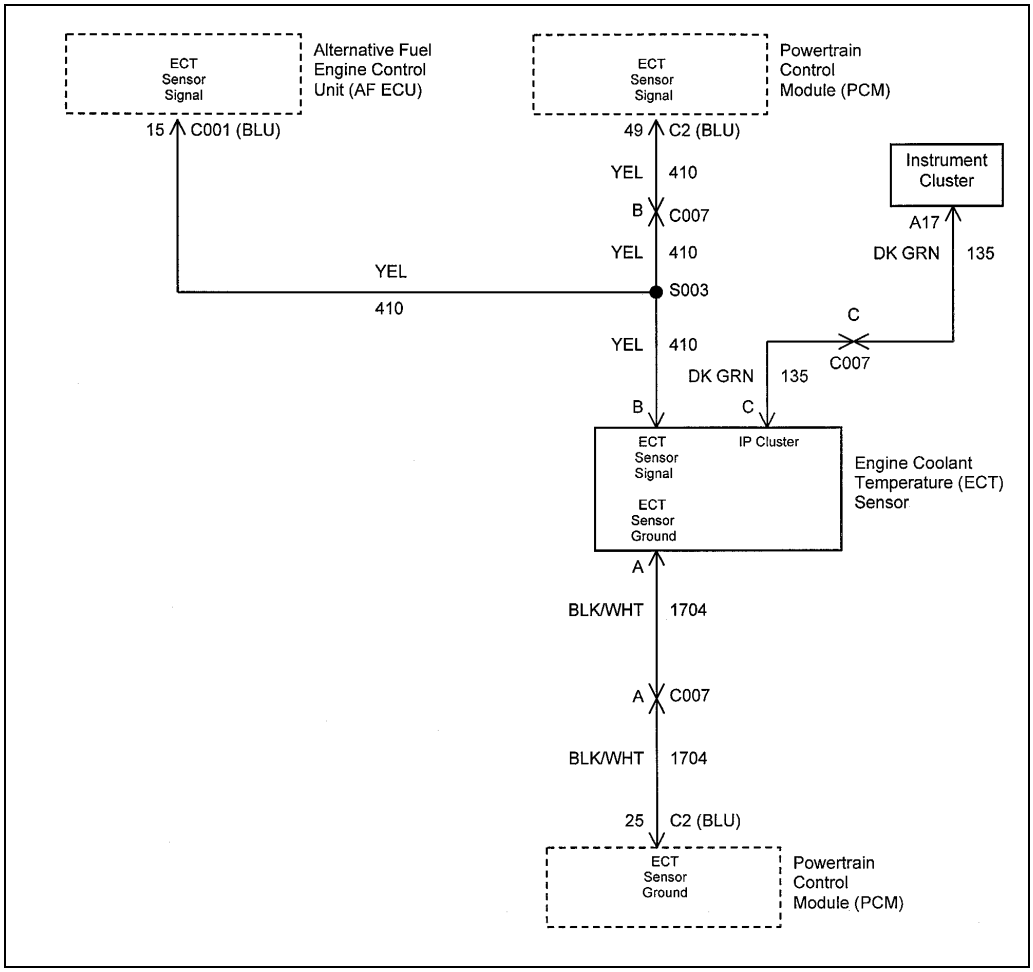
Step	Action	Value(s)	Yes	No
8	1. Connect a duty cycle monitoring tool at C012 test connector as follows: **FSA:** Yellow clip to pin A (ORG). Green clip to pin B (PPL). Red clip to 12V power. Black clip to ground. **DVOM:** Set for duty cycle percentage and connect between pin A (ORG) and a good ground. 2. Observe the duty cycle of the ICS. Is the ICS duty cycle within the specified range?	48% to 52% (1999) or 25% to 75% (2000)	Go to *Step 9*	Go to *Step 16*
9	1. Using a DVOM, backprobe the ICS electrical connector terminals. 2. Observe the duty cycle of the ICS. Is the ICS duty cycle within the specified range?	48% to 52% (1999) or 25% to 75% (2000)	Go to *Step 26*	Go to *Step 16*
10	1. Remove the hose from the RCV valve and install a vacuum cap over the RCV port. 2. Operate the engine at IDLE for approximately 15 seconds. 3. Observe the duty cycle reading of the FCS. Is the FCS duty cycle within the specified range?	25% to 75%	Go to *Step 15*	Go to *Step 11*
11	1. Observe the scan tool MAF reading. 2. Raise the engine speed to approximately 2500 RPM or greater than 28 g/s MAF. 3. Observe the duty cycle reading of the FCS. Is the FCS duty cycle within the specified range?	25% to 75%	Go to *Step 16*	Go to *Step 12*
12	1. Turn the engine OFF. 2. Disconnect the ECU connector C002. 3. Disconnect the FCS electrical connector. 4. Check the FCS ground circuit in terminal B (YEL) for continuity to the ECU connector. 5. Check the FCS ground circuit in terminal B (YEL) for short to ignition power or ground. Was a problem found and repaired?	—	Go to *Step 36*	Go to *Step 24*

Step	Action	Value(s)	Yes	No
13	1. Turn the ignition OFF. 2. Remove the mixer bonnet assembly. 3. Start the engine. **Note:** This action may set AF ECU and PCM diagnostic codes for the MAF sensor. 4. Using a DVOM backprobe the ETC electrical connector terminals. 5. Observe the voltage reading at the ETC connector. Is the voltage within the specified range?	12.6 V to 15.1 V	Go to *Step 28*	Go to *Step 18*
14	1. Remove the hose from the RCV valve and install a vacuum cap over the RCV port. 2. Operate the engine at 2500 RPM for approximately 15 seconds. 3. With the engine running at 2500 RPM observe the FCS duty cycle at the FSA or the DVOM. Is the FCS duty cycle within the specified range?	25% to 75%	Go to *Step 15*	Go to *Step 32*
15	Replace the regulator control valve (RCV). Refer to *Regulator Control Valve Replacement.* Is the action complete?	—	Go to *Step 36*	—
16	1. Connect the positive lead of the DVOM to an ignition power source. 2. Backprobe the ICS connector pin B (ORG). 3. Connect the negative lead of the DVOM to terminal B. Is the ICS duty cycle within the specified range?	48% to 52% (1999) or 25% to 75% (2000)	Go to *Step 27*	Go to *Step 17*
17	1. Disconnect the ECU connector C002. 2. Check the ICS ground circuit between the ICS connector terminal B and C002 for an open or short to ignition power or ground. Was a problem found and repaired?	—	Go to *Step 36*	Go to *Step 21*
18	1. Connect the negative lead of the DVOM to a known good ground. 2. Backprobe the ETC solenoid connector pin A (GRY). 3. Connect the positive lead of the DVOM to terminal A. Is the ETC voltage within the specified range?	12.6 V to 15.1 V	Go to *Step 19*	Go to *Step 20*
19	Check the ETC ground circuit and connections between the ETC solenoid connector, ECU C001 and PCM C1-45 for an open or short to ignition power. Was a problem found and repaired?	—	Go to *Step 36*	Go to *Step 21*

Step	Action	Value(s)	Yes	No
20	The ETC solenoid ignition circuit is open. Locate and repair the open or short to ground in the ETC ignition power circuit from pin A. Is the action complete?	—	Go to *Step 36*	—
21	1. Disconnect ECU connector C001. 2. Turn the ignition ON leaving the engine OFF. 3. Check ECU cavity C001 pin 26 for a short to power. Was a problem found?	—	Go to *Step 23*	Go to *Step 36*
22	The ICS ignition circuit is open or shorted to ground. Check the ICS ignition circuit in the ICS connector terminal A for ignition power. Was a problem repaired?	—	Go to *Step 36*	—
23	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 25*	—
24	Check the vacuum hoses between the mixer, LPR and the FCS for kinks, obstructions or leakage. Was a problem found and repaired?	—	Go to *Step 36*	Go to *Step 29*
25	Repair the open or damaged circuit. Is the action complete?	—	Go to *Step 36*	—
26	Check the fuel hose between the LPR and the ICS for kinks or obstructions. Was a problem found and repaired?	—	Go to *Step 36*	Go to *Step 27*
27	Replace the Idle Control Solenoid (ICS). Refer to *Idle Control Solenoid Replacement.* Is the action complete?	—	Go to *Step 31*	—
28	1. Inspect the hoses between the ETC solenoid and the mixer for leakage and proper connection. 2. Check the mixer cover for proper installation and condition. Was a problem found and repaired?	—	Go to *Step 36*	Go to *Step 30*
29	Replace the Fuel Control Solenoid (FCS). Refer to *Fuel Control Solenoid (FCS) Replacement*. Is the action complete?	—	Go to *Step 31*	—
30	Replace the ETC Solenoid. Refer to *ETC Solenoid Replacement*. Is the action complete?	—	Go to *Step 36*	—

Step	Action	Value(s)	Yes	No
31	1. Return the fuel system to normal operating condition. 2. Observe the scan tool MAF reading. 3. Raise the engine speed to approximately 2500 RPM or greater than 28 g/s MAF. 4. Observe the duty cycle reading of the FCS. Is the FCS duty cycle within the specified range?	25% to 75%	Go to *Step 36*	Go to *Step 32*
32	Check all vacuum hoses and mixer connections for leakage. Was a problem found and repaired?	—	Go to *Step 36*	Go to *Step 33*
33	Replace the fuel mixer. Refer to *Fuel Mixer Replacement.* Is the action complete?	—	Go to *Step 36*	—
34	The AF fuel control system is operating normally. Refer to *Symptoms Diagnosis.* 1. Disconnect all test equipment. 2. If you were sent to this routine by another diagnostic chart, return to the previous diagnostic procedure. Is the action complete?	—	System OK	—
35	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	Go to *Step 36*	—
36	1. Disconnect all test equipment. 2. Start the engine. 3. Using SNOOP® or equivalent, leak check any fuel system repairs made. Is the action complete?	—	System OK	—

DTC 14 ECT Sensor Circuit High Voltage



Circuit Description

The Engine Coolant Temperature (ECT) sensor is a thermo resistor that controls the signal voltage to the PCM. The PCM applies a voltage on the 5 volt reference circuit to the sensor. When the engine is cold, the sensor resistance is high; therefore, the PCM senses a high voltage signal, and the PCM indicates a low coolant temperature. As the engine warms, the sensor resistance becomes less and the voltage drops indicating high coolant temperature. At normal engine operating temperature (85°C to 95°C), the voltage measures about 1.5 to 2.0 volts. The AF ECU receives coolant temperature directly from the ECT signal circuit.
This is a type B DTC.

Conditions for Setting the DTC

The following conditions will set the DTC:

- The engine has been running longer than 5 seconds at intake air temperatures greater than 0°C (32°F)
  or
  Longer than 600 seconds at intake air temperatures less than 0°C (32°F).
- ECT circuit voltage is higher than 4.395 Volts.

Action Taken When the DTC Sets

The ECU sets the DTC 14 after 2 consecutive driving cycles with the fault active.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
After starting the engine, the temperature should rise steadily to about 90°C (194°F), then stabilize when the thermostat opens. A faulty connection or an open in the 5 volt reference circuit or the sensor ground circuit results in a DTC 14.

Use the Temperature vs. Resistance Value Table to test the coolant sensor at various temperature levels in order to evaluate the possibility of a skewed (mis-scaled) sensor. A skewed sensor could result in poor driveability complaints. Refer to *Temperature vs. Resistance.*

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. If the fault is present, the engine coolant temperature voltage measures greater than 4.395 volts.
5. This test will determine if the ECU is the cause of DTC 14.

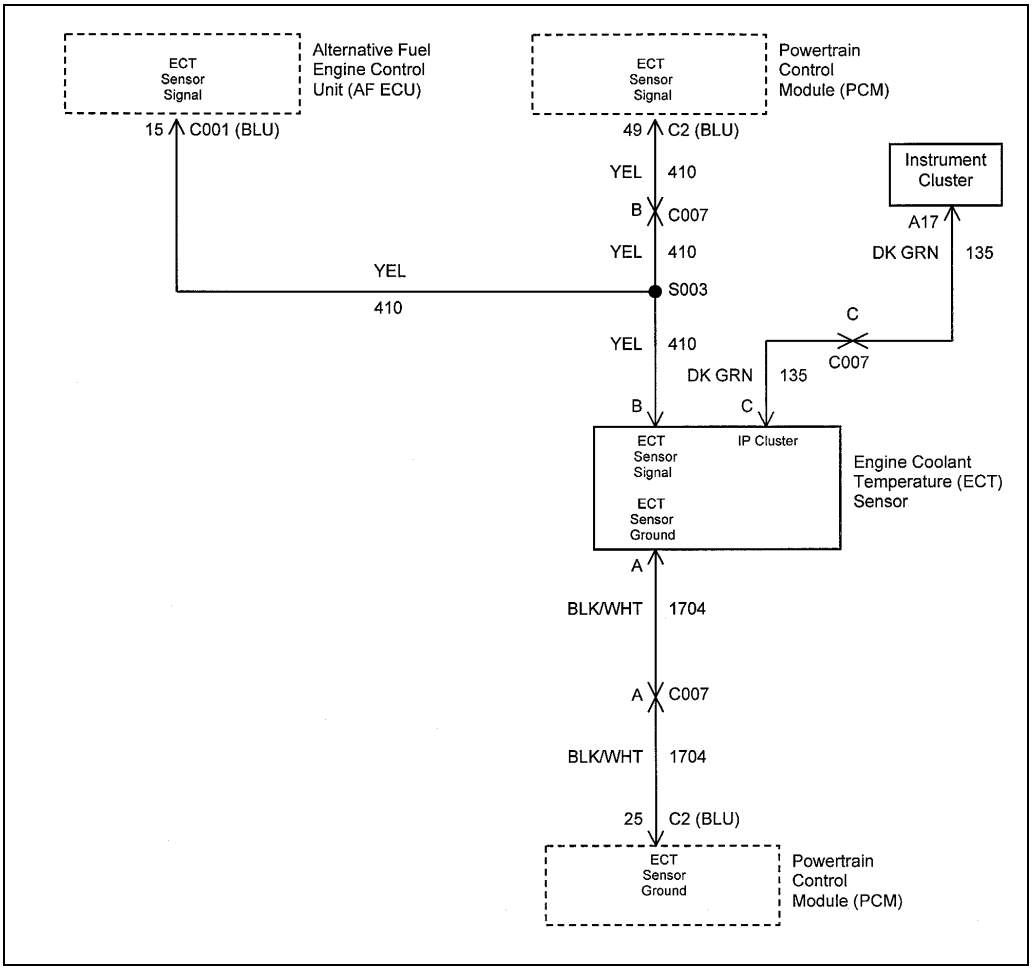
DTC 14 ECT Sensor Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Connect the scan tool. 2. Start the engine. 3. Observe the ECT sensor reading. Does the scan tool display the ECT sensor reading LESS than the specified value?	-35°C -31°F	Go to *DTC P0118 ECT Sensor Circuit High Voltage* in the GM MD Service Manual	Go to *Step 3*
3	Using a DVOM, backprobe the ECT sensor signal in the ECU connector. Does the DVOM display the ECT sensor signal GREATER than the specified value?	4.39V	Go to *Step 4*	Go to *Step 5*
4	1. Turn the engine OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. Does the DVOM display the ECT sensor signal GREATER than the specified value?	4.39V	Go to *Step 7*	Go to *Step 6*
5	1. Disconnect the ECT sensor. 2. Using a DVOM, check for continuity of the ECT circuit between the ECT connector and the ECU. Is there continuity?	—	Go to *Step 9*	Go to *Step 13*
6	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 16*	—

Step	Action	Value(s)	Yes	No
7	1. Turn the ignition OFF. 2. Disconnect the ECT sensor connector. 3. Jumper the ECT sensor harness terminals together. 4. Turn the ignition ON. 5. Observe the engine coolant temperature parameter on the scan tool. Is the ECT sensor at the specified value?	140°C (284°F)	Go to *Step 10*	Go to *Step 8*
8	Jumper the ECT sensor signal circuit to a known good ground. Is the ECT sensor at the specified value?	140°C (284°F)	Go to *Step 11*	Go to *Step 12*
9	The DTC is intermittent. If no additional DTCs were stored, refer to the Diagnostic Aids. If any additional DTCs are stored, refer to those tables. Are any additional DTCs set?	—	Go to *the applicable DTC Table*	—
10	Inspect the ECT sensor connector and the PCM connector for the proper connection. Was a problem found?	—	Go to *Step 13*	Go to *Step 14*
11	Check the ECT sensor ground circuit for an open between the ECT sensor and the PCM. Was a problem found?	—	Go to *Step 13*	Go to *Step 15*
12	Check the ECT sensor signal circuit for an open between the ECT sensor and the PCM. Was a problem found?	—	Go to *Step 13*	Go to *Step 15*
13	Repair the circuit as necessary. Is the repair complete?	—	Go to *Step 16*	—
14	Replace the ECT sensor. Is the replacement complete?	—	Go to *Step 16*	—
15	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the replacement complete?	—	Go to *Step 16*	—
16	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light still illuminates. Did the diagnostic run and pass?	—	Go to *Step 17*	Go to *Step 2*

Step	Action	Value(s)	Yes	No
17	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC Table	System OK

DTC 15 ECT Sensor Circuit Low Voltage



Circuit Description

The Engine Coolant Temperature (ECT) sensor is a thermo resistor that controls the signal voltage to the PCM. The PCM applies a voltage on the 5 volt reference circuit to the sensor. When the engine is cold, the sensor resistance is high; therefore, the PCM senses a high voltage signal, and the PCM indicates a low coolant temperature. As the engine warms, the sensor resistance becomes less and the voltage drops indicating high coolant temperature. At normal engine operating temperature (85°C to 95°C), the voltage measures about 1.5 to 2.0 volts. The AF ECU receives coolant temperature directly from the ECT signal circuit.
This DTC is a type B DTC.

Conditions for Setting the DTC

The following conditions will set the DTC:

- The engine has been running longer than 5 seconds.
- ECT circuit voltage is less than 0.019 volts.

Action Taken When the DTC Sets

The ECU sets the DTC 15 after 2 consecutive driving cycles with the fault active.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
After starting the engine, the temperature should rise steadily to about 90°C (194°F) then stabilize when the thermostat opens. A faulty connection or an

open in the 5 volt reference circuit or the sensor ground circuit results in a DTC 15.

Use the Temperature vs. Resistance Value Table to test the coolant sensor at various temperature levels in order to evaluate the possibility of a skewed (mis-scaled) sensor. A skewed sensor could result in poor driveability complaints. Refer to *Temperature vs. Resistance.*

Test Description

The numbers below refer to the step numbers on the diagnostic table.

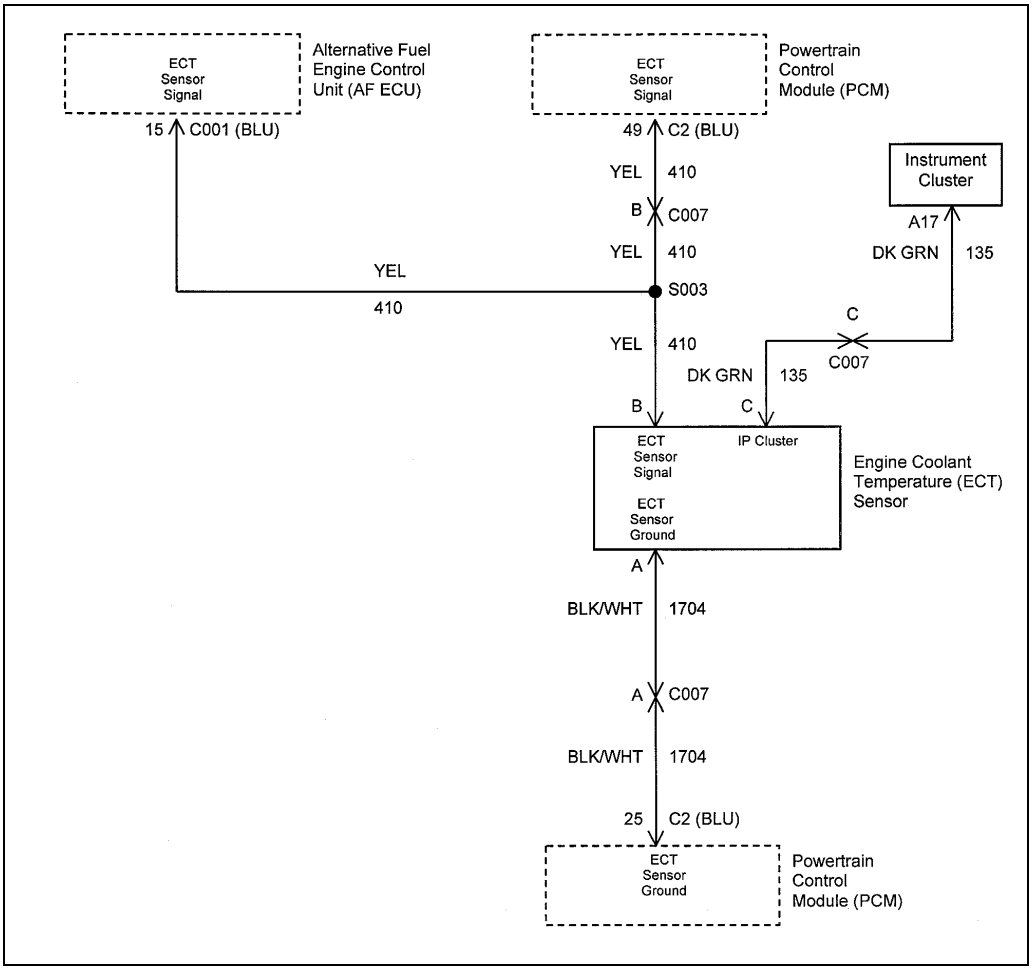
3. If the fault is present, the engine coolant temperature voltage at the ECU measures less than 0.019 volts. If the PCM is reading below 190°C (282°F) and the ECU voltage is above 0.019, refer to the base vehicle service manual.

DTC 15 ECT Sensor Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Connect the scan tool. 2. Start the engine. 3. Observe the ECT sensor reading. Does the scan tool display the ECT sensor reading GREATER than the specified value?	139°C (282°F)	Go to *DTC P0117 ECT Sensor Circuit Low Voltage* in the GM MD Service Manual	Go to *Step 3*
3	Using a DVOM, backprobe the ECT sensor signal in the ECU connector. Does the DVOM display the ECT sensor signal LESS than the specified value?	0.019 V	Go to *Step 4*	Go to *Step 5*
4	1. Turn the engine OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. Does the DVOM display the ECT sensor signal LESS than the specified value?	0.019 V	Go to *Step 7*	Go to *Step 6*
5	1. Disconnect the ECT sensor. 2. Using a DVOM, check for continuity of the ECT circuit between the ECT connector and the ECU. Is there continuity?	—	Go to *Step 9*	Go to *Step 13*
6	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 16*	—
7	1. Turn the ignition OFF. 2. Disconnect the ECT sensor connector. 3. Turn the ignition ON. 4. Observe the engine coolant temperature parameter on the scan tool. Is the ECT sensor at the specified value?	-35°C (-31°F)	Go to *Step 10*	Go to *Step 8*

Step	Action	Value(s)	Yes	No
8	Jumper the ECT sensor signal circuit to a known good ground. Is the ECT sensor at the specified value?	140°C (284°F)	Go to *Step 11*	Go to *Step 12*
9	The DTC is intermittent. If no additional DTCs were stored, refer to the Diagnostic Aids. If any additional DTCs are stored, refer to those tables. Are any additional DTCs set?	—	Go to the applicable DTC Table	—
10	Inspect the ECT sensor connector and the PCM connector for the proper connection. Was a problem found?	—	Go to *Step 13*	Go to *Step 14*
11	Check the ECT sensor ground circuit for an open between the ECT sensor and the PCM. Was a problem found?	—	Go to *Step 13*	Go to *Step 15*
12	Check the ECT sensor signal circuit for an open between the ECT sensor and the PCM. Was a problem found?	—	Go to *Step 13*	Go to *Step 15*
13	Repair the circuit as necessary. Is the repair complete?	—	Go to *Step 16*	—
14	Replace the ECT sensor. Is the replacement complete?	—	Go to *Step 16*	—
15	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the replacement complete?	—	Go to *Step 16*	—
16	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light still illuminates. Did the diagnostic run and pass?	—	Go to *Step 17*	Go to *Step 2*
17	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC Table	System OK

DTC 16 ECT Excessive Time to Closed Loop



Circuit Description

While the engine is warming, the ECU monitors the ECT sensor in order to determine how long the engine takes to achieve a specified coolant temperature increase required for a Closed Loop operation.
A DTC sets if the ECU determines that the engine does not achieve a predetermined engine temperature increase in a specified amount of time. This DTC will not run if either the intake air or the engine coolant temperature measure below a specific temperature. The ECU will only run this DTC on a cold start and only once per cold start. This DTC is a type A DTC.

Conditions for Setting the DTC

The following conditions will set the DTC:

- Engine run time is greater than 600 seconds.
- None of the following DTCs are active: 14, 15, 23, 25.
- Intake air temperature is greater than 5°F (-15°C).
- Vehicle speed is greater than 5 MPH.
- The ECT at start is less than 91°F (33°C).
- The ECT is greater than 1°F (-17°C).
- ECT has not increased by 25°C.

Action Taken When the DTC Sets

The ECU will set DTC 16 and illuminate the MIL light after 1 fault has occurred.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72 °F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
When a DTC 16 sets, a skewed ECT sensor or an engine thermostat that does not operate correctly is indicated.
A poor connection, a rubbed through wire insulation, or a wire broken inside the insulation may cause an intermittent.

Check for the following conditions:

- A poor connection or damaged harness. Inspect the ECU harness connector for the following conditions:
  - Backed out terminals
  - Improper mating
  - Broken locks
  - Improperly formed or damaged terminals
  - Poor terminal to wire connection and
  - Damaged harness.
- The intermittent test: If the connections and the harness check OK, monitor a DVOM connected to the ECU terminal while moving the related connectors and the wiring harness. If the failure is induced, the voltage reading changes. This may help isolate the location of the malfunction.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

6. This test checks the engine warm-up rate.
8. This test checks the coolant sensor reading and the actual coolant temperature.

DTC 16 ECT Excessive Time to Closed Loop

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Disconnect ECU connector C001. 2. Disconnect ECT connector. 3. Using a DVOM, check the resistance of the ECT signal circuit between the connectors. Is the resistance below the specified value?	0.5 Ω	Go to *Step 4*	Go to *Step 3*
3	The circuit has high resistance, inspect ECU connector C001 and ECT connectors for loose or corroded pins. Has the problem been corrected ?	—	Go to *Step 10*	—
4	Reconnect all connectors. Is the action complete ?	—	Go to *Step 5*	—
5	1. Allow the engine to cool completely. 2. Install the scan tool. 3. Turn ON the ignition. 4. Compare the IAT and the ECT. The values should be close. Are they close?	—	Go to *Step 6*	Go to *DTC PO117 ECT Sensor Circuit Low Voltage* in the GM MD Service Manual

Step	Action	Value(s)	Yes	No
6	1. Verify that the heater / defroster coolant valves are turned OFF. 2. Start the engine. 3. Note ECT at start temperature. 4. Run the engine while monitoring the ECT on the scan tool. Does the ECT value increase steadily greater than the above the specified value over the starting ECT value within 10 minutes?	45°F (25°C)	Go to *Diagnostic Aids*	Go to *Step 7*
7	1. Turn OFF the ignition. 2. Allow the engine to cool. 3. Check the cooling system coolant level. Was a problem found?	—	Go to *Engine Cooling System* in the GM MD Service Manual	Go to *Step 8*
8	1. Turn ON the ignition. 2. Compare the ECT display on the scan tool to the actual coolant temperature. The values should be close. Are they close?	—	Go to *Engine Cooling System* in the GM MD Service Manual	Go to *Step 9*
9	Replace the ECT sensor. Is the replacement complete?	—	Go to *Step 10*	—
10	1. Start the engine. 2. Idle at normal operating temperature. 3. Operate the vehicle within the conditions for setting this DTC as outlined in the supporting text. 4. Check to see if the MIL light still illuminates. Did the diagnostic run and pass?	—	Go to *Step 11*	Go to *Step 2*
11	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC Table	System OK

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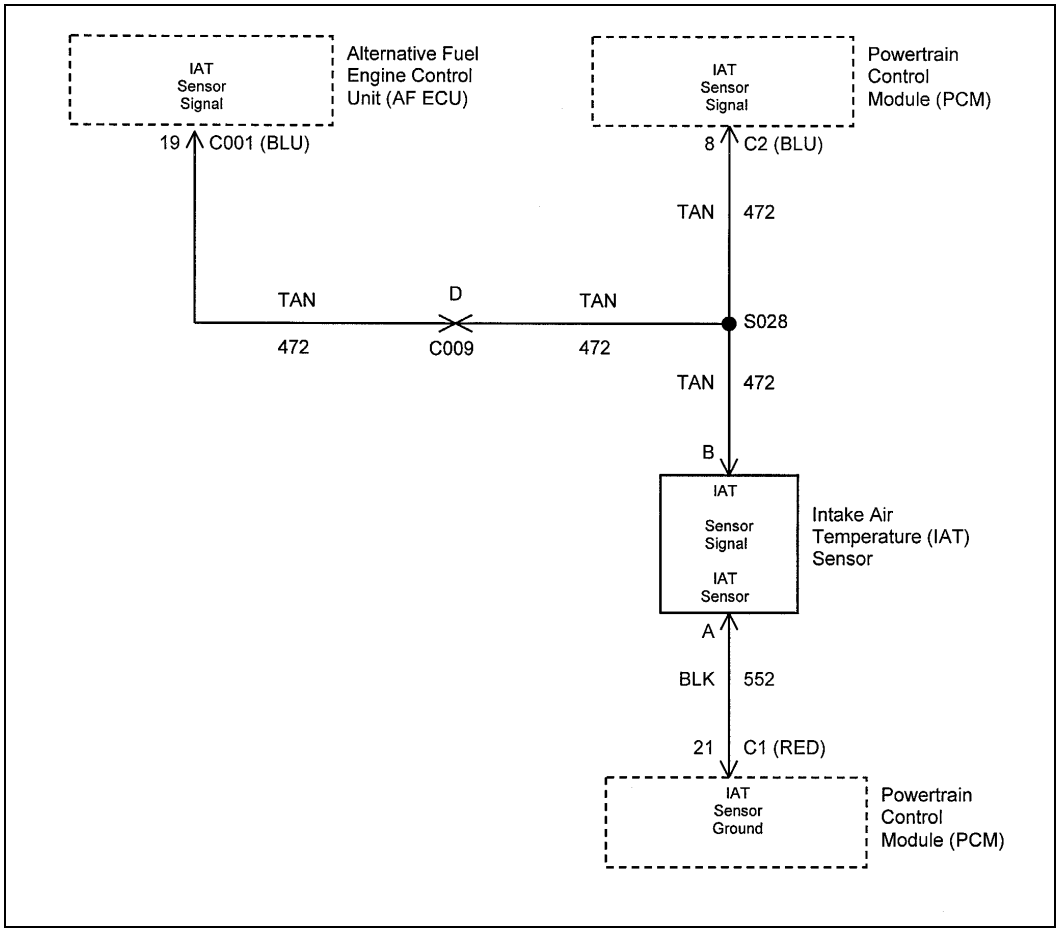
DTC 23 IAT Sensor Circuit Low Voltage



Circuit Description

The Intake Air Temperature (IAT) sensor is a thermo resistor located in the fresh air duct to the throttle body to monitor the temperature of the air entering the throttle body. The PCM applies 5 volts to the sensor on a 5 volt reference circuit. When the air is cool, resistance in the sensor measures high and the ECU senses a high voltage signal. If the air is warm, the sensor resistance measures low and the ECU senses a low voltage signal.
This DTC is a type B DTC.

Conditions for Setting the DTC

The following conditions will set the DTC:
- Vehicle speed is greater than 1 mph.
- Engine run time is greater than 100 seconds.
- IAT voltage is below 0.019 volts.

Action Taken When the DTC Sets

The ECU sets the DTC 23 after 2 consecutive driving cycles with the fault active.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
A scan tool indicates the temperature of the ambient air entering the throttle body. The air temperature should read very close to the temperature of the outside air. The air temperature should rise gradually as the engine warms up and the underhood temperature increases. Check for poor connections at the ECU and IAT sensor by wiggling the connector gently and monitoring the IAT voltage on a DVOM connected to the ECU connector. If the voltage waivers, repair the connector that caused the condition.

Also, a sensor may become skewed or mis-scaled. The Temperature vs. Resistance value table will help to detect a skewed sensor. Refer to *Temperature vs. Resistance.*

Test Description

The numbers below refer to the step numbers on the diagnostic table.

Important: Use the same diagnostic test equipment for all of the measurements.

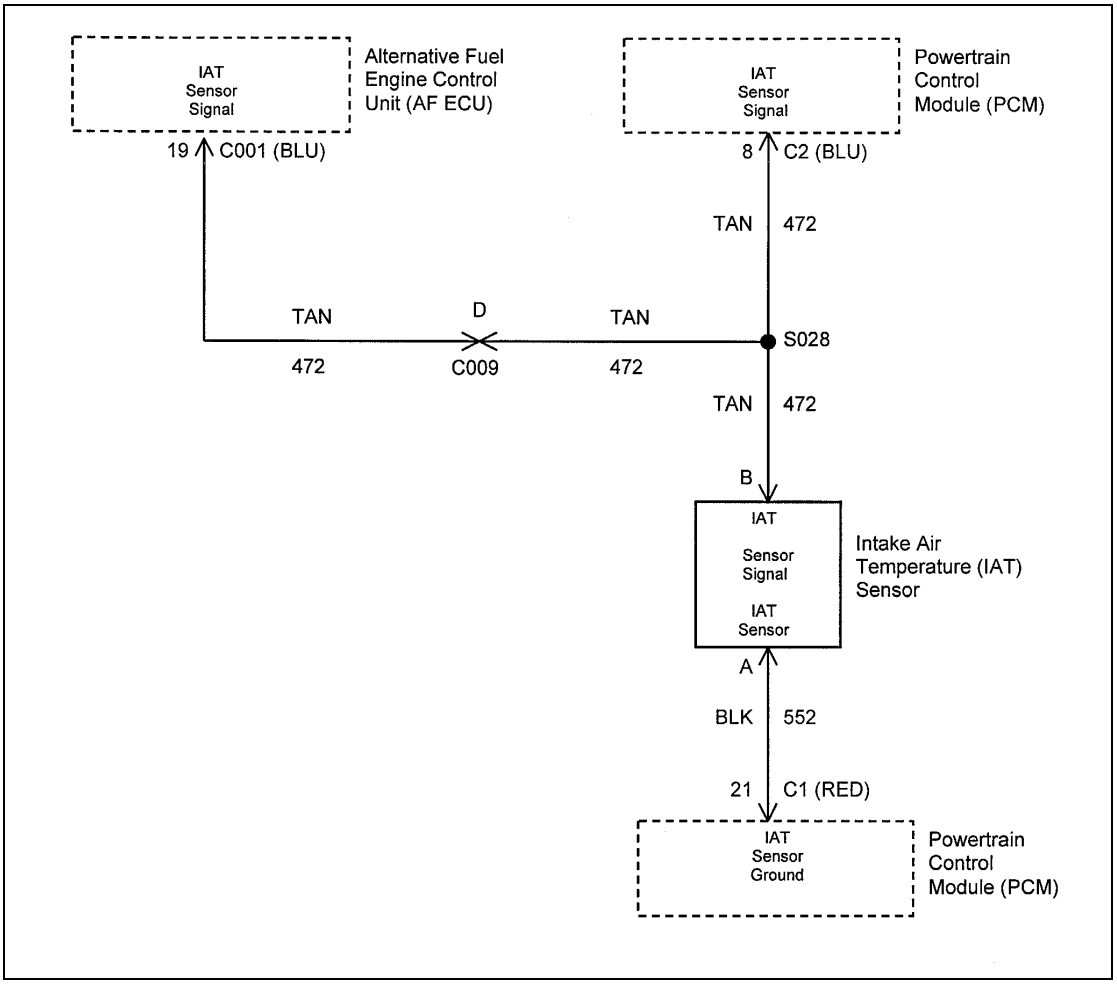
3. With the ECU connector disconnected and the voltage still present, this eliminates the ECU as the possible cause of the fault.
4. If the IAT sensor circuit voltage measures less than 0.019 volts, the conditions for the DTC are still present, and the problem is not intermittent.

DTC 23 IAT Sensor Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Connect the scan tool. 2. Turn the ignition ON leaving the engine OFF. 3. Monitor the IAT sensor voltage. Is the IAT sensor reading above the specified value?	139°C (282°F)	Go to *Step 3*	Go to *Step 4*
3	1. Turn the ignition OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. Does the scan tool display a IAT sensor reading above the specified value?	139°C (282°F)	Go to *Step 8*	Go to *Step 6*
4	Using a DVOM, backprobe the IAT sensor signal in the ECU connector. Does the DVOM display the IAT sensor signal less than the specified value?	0.019 V	Go to *Step 5*	Go to *Step 10*
5	1. Disconnect ECU connector C001. 2. Disconnect the IAT sensor connector. 3. Check for continuity of the IAT sensor signal circuit between the connectors. Is there continuity?	—	Go to *Step 6*	Go to *Step 11*
6	Inspect the ECU connector for loose, corroded or damaged pins. Was a problem found?	—	Go to *Step 11*	Go to *Step 7*
7	Replace the ECU. Refer to *ECU Replacement.* Is the action complete	—	Go to *Step 15*	—
8	1. Turn OFF the engine. 2. Turn ON the ignition. 3. Disconnect the IAT sensor connector. 4. Observe the IAT sensor voltage on the scan tool. Is the IAT sensor voltage at the specified value?	-39°C (-38°F)	Go to *Step 13*	Go to *Step 9*

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Disconnect the PCM connector. 3. Using a DVOM, check the IAT sensor signal circuit for a short to ground. Was a problem found?	—	Go to *Step 12*	Go to *Step 14*
10	The DTC is intermittent. If no additional DTCs are stored, refer to the Diagnostic Aids. If additional DTCs were stored, refer to those tables. Are any additional DTCs set?	—	Go to the applicable DTC Table	Refer to *Diagnostic Aids*
11	Repair the circuit as necessary. Is the repair complete?	—	Go to *Step 15*	—
12	Repair the short to the ground in the IAT signal circuit. Is the repair complete?	—	Go to *Step 15*	—
13	Replace the IAT Sensor. Is the replacement complete?	—	Go to *Step 15*	—
14	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the replacement complete?	—	Go to *Step 15*	—
15	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light still illuminates. Did the diagnostic run and pass?	—	Go to *Step 16*	Go to *Step 2*
16	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC Table	System OK

DTC 25 IAT Sensor Circuit High Voltage



Circuit Description

The Intake Air Temperature (IAT) sensor is a thermo resistor located in the fresh air duct to the throttle body to monitor the temperature of the air entering the throttle body. The PCM applies 5 volts to the sensor on a 5 volt reference circuit. When the air is cool, resistance in the sensor measures high and the ECU senses a high voltage signal. If the air is warm, the sensor resistance measures low and the ECU senses a low voltage signal. This DTC is a type B DTC.

Conditions for Setting the DTC

The following conditions will set the DTC:

All of the conditions below must be met for at least 10 seconds:

- Vehicle speed must be less than 1 mph.
- Air flow must be less than 250 grams per second.
- IAT voltage is greater than 4.88 volts.
- If ECT at start is greater than 0°C, the DTC will test at 100 seconds of run time
  or
- If ECT at start is less than 0°C, the DTC will test at 600 seconds of run time.

Action Taken When the DTC Sets

The ECU sets the DTC 25 after 2 consecutive driving cycles with the fault active.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
A scan tool indicates the temperature of the ambient air entering the throttle body. The air temperature should read very close to the temperature of the outside air. The air temperature should rise gradually as the engine warms up and the underhood temperature increases. Check for poor connections at the ECU and IAT sensor by wiggling the connector gently and monitoring the IAT voltage on a DVOM connected to the ECU connector. If the voltage waivers, repair the connector that caused the waiver.
Also, a sensor may become skewed or mis-scaled. The Temperature vs. Resistance value table will help to detect a skewed sensor. Refer to *Temperature vs. Resistance*.

Test Description

The numbers below refer to the step numbers on the diagnostic table.
Important: Use the same diagnostic test equipment for all of the measurements.

3. If the IAT sensor circuit voltage measures greater than 4.88 volts, the conditions for the DTC are still present, and the problem is not intermittent.
4. With the ECU connector disconnected and the voltage still present, this eliminates the ECU as the possible cause of the fault

DTC 25 IAT Sensor Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Connect the scan tool. 2. Turn the ignition ON leaving the engine OFF. 3. Monitor the IAT sensor voltage. Is the IAT sensor voltage at the specified value?	-39°C (-38°F)	Go to *DTC P0113 IAT Sensor Circuit High Voltage* in the GM MD Service Manual	Go to *Step 3*
3	Using a DVOM, backprobe the IAT sensor signal in the ECU connector. Does the DVOM display the IAT sensor signal greater than the specified value?	4.88 V	Go to *Step 4*	Go to *Step 5*
4	1. Turn OFF the ignition. 2. Disconnect ECU connector C001. 3. Turn ON the ignition. Does the DVOM display the IAT sensor signal greater than the specified value?	4.88 V	Go to *Step 7*	Go to *Step 6*
5	1. Disconnect the IAT sensor. 2. Using a DVOM, check for continuity of the IAT circuit between the IAT connector and the ECU. Is there continuity?	—	Go to *Step 9*	Go to *Step 13*
6	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 16*	—

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the engine. 2. Turn ON the ignition switch. 3. Disconnect the IAT sensor connector. 4. Jumper the IAT sensor harness terminals together. Does the scan tool display the IAT sensor at the specified value?	140°C (284°F)	Go to *Step 10*	Go to *Step 8*
8	Jumper the IAT sensor signal circuit to a known good ground. Does the scan tool display the IAT sensor at the specified value?	140°C (284°F)	Go to *Step 11*	Go to *Step 12*
9	The DTC is intermittent. If no additional DTCs are stored, refer to the Diagnostic Aids. If additional DTCs are set, refer to those tables. Are any additional DTCs set?	—	Go to the applicable DTC Table	—
10	Inspect the sensor connector and the PCM connector for the proper connection. Was a problem found?	—	Go to *Step 13*	Go to *Step 14*
11	Check the IAT sensor ground circuit for an open between the IAT sensor and the PCM. Was a problem found?	—	Go to *Step 13*	Go to *Step 15*
12	Check the sensor signal circuit for an open between the IAT sensor, PCM and the ECU. Was a problem found?	—	Go to *Step 13*	Go to *Step 15*
13	Repair the circuit as necessary. Is the repair complete?	—	Go to *Step 16*	—
14	Replace the IAT Sensor. Is the replacement complete?	—	Go to *Step 16*	—
15	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the replacement complete?	—	Go to *Step 16*	—

Step	Action	Value(s)	Yes	No
16	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light still illuminates. Did the diagnostic run and pass?	—	Go to *Step 17*	Go to *Step 2*
17	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC 31 ETC System Fault

Circuit Description

If a PCM Throttle Actuator Control (TAC) DTC (P1514, P1515, P1516, or P1518) is detected by the AF ECU, it will set DTC 31 and enter ETC Fault Mode. In this mode, the AF ECU issues a command to de-energize the ETC solenoid. The air valve vacuum in the mixer is vented to atmosphere, causing the air valve to close and reduce airflow through the mixer (to a default limit value 6 g/s – 9 g/s). This forces an idle condition. The AF ECU commands the idle control solenoid (ICS) to fuel the engine and maintain fuel control.
This DTC is a type A DTC.

Conditions for Setting the DTC

The following conditions will set the DTC:

- The PCM has initiated a reduced power mode due to a TAC system failure. DTCs P1514, P1515, P1516, P1518.

Action Taken When the DTC Sets

The ECU will set DTC 31 and illuminate the MIL light after 1 fault has occurred. The ECU will initiate reduced power mode by closing the mixer air valve.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72 °F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
A poor connection, a rubbed through wire insulation, or a wire broken inside the insulation may cause an intermittent.

Check for the following conditions:

- A poor connection or damaged harness. Inspect the ECU harness connector for the following conditions:
  - Backed out terminals
  - Improper mating
  - Broken locks
  - Improperly formed or damaged terminals
  - Poor terminal to wire connection and
  - Damaged harness.
- The intermittent test: If the connections and the harness check OK, monitor a DVOM connected to the ECU terminal while moving the related connectors and the wiring harness. If the failure is induced, the voltage reading changes. This may help isolate the location of the malfunction.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

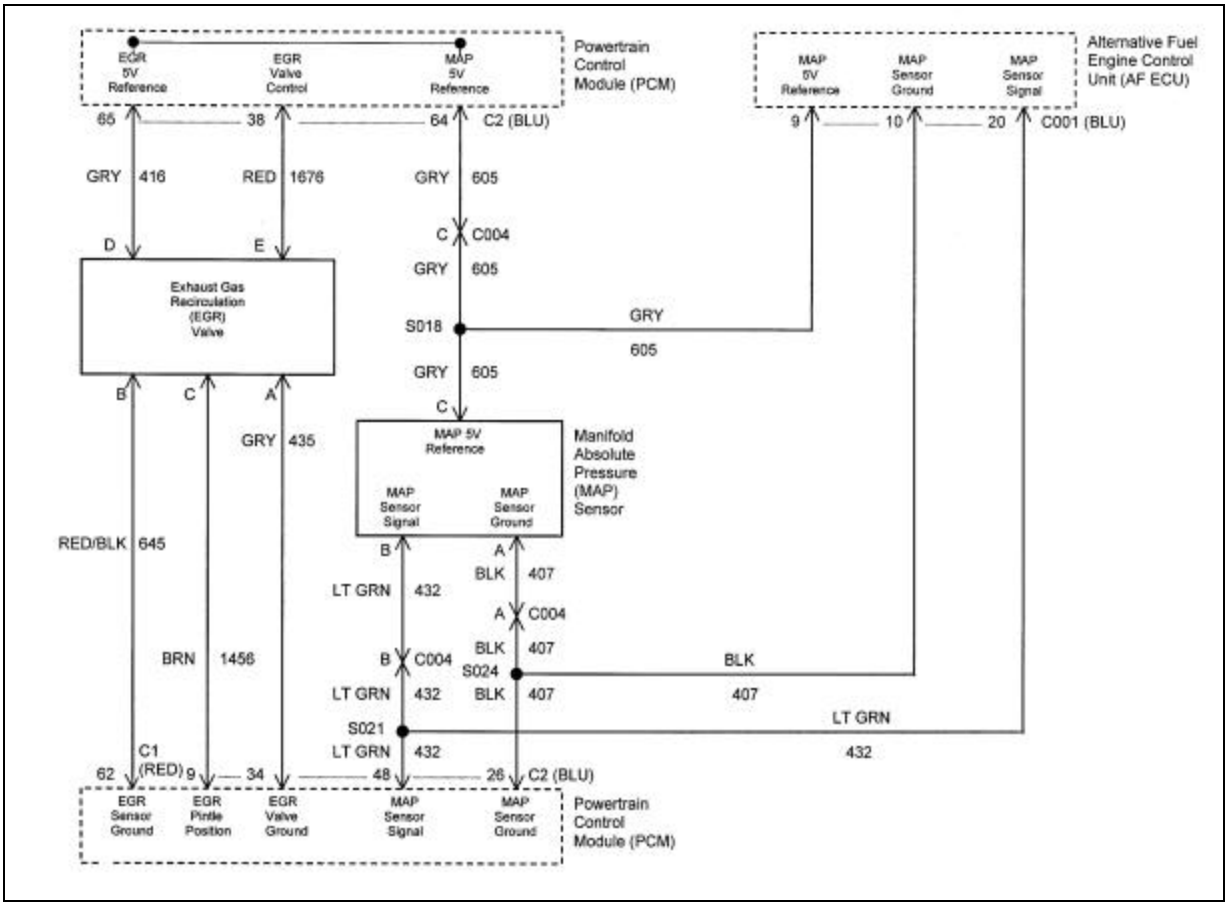
2. This test verifies that a PCM DTC has caused DTC 31 to be set by the AF ECU.
3. This test checks the ETC circuit between the PCM and ECU.

DTC 31 ETC System Fault

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	Were PCM codes P1514, P1515, P1516, or P1518 retrieved?	—	Go to *Step 6*	Go to *Step 3*
3	1. Disconnect the PCM connector J1. 2. Disconnect the ECU connector C001. 3. Check the ETC fault circuit for an open, short to ground or ignition power. Was a problem found and repaired?	—	Go to *Step 6*	Go to *Step 4*

Step	Action	Value(s)	Yes	No
4	Check for a poor connection at the ECU connector C001. Was a problem found and repaired?	—	Go to *Step 6*	Go to *Step 5*
5	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 6*	—
6	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC Table	System OK

DTC 34 MAP Sensor Circuit Low Voltage



Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in the intake manifold pressure (vacuum). A 5 volt reference is applied to the sensor. A variable resistor moves in relation to manifold pressure and a voltage signal is sent back to the ECU on the 5 volt reference circuit. This voltage signal varies from 1.0-1.5 volts at closed throttle (high vacuum) to 4.0-4.5 volts at wide open throttle (low vacuum). This DTC is a type B DTC.

Conditions for Setting the DTC

- None of the following DTCs are active: 21, 22, and 26.
- MAP circuit voltage is less than 0.098 volts.
- TP sensor position is less than 4% at RPMs less than 1200
  or
  TP sensor position is greater than 20% at RPMs greater than 1300.

Action Taken When the DTC Sets

The ECU sets the DTC 34 after 2 consecutive driving cycles with the fault active.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
With the ignition ON and the engine OFF, the manifold pressure is equal to the atmospheric pressure with the signal voltage high. The ECU uses this information as an indication of the altitude of the vehicle.

Comparison of this reading with a known good vehicle using the same sensor is a good way to check the accuracy of a suspect sensor. Readings should be the same, ±0.4 volt.
Refer to *Intermittents.*
Important: The electrical connector must remain securely fastened.
Important: After removing the MAP sensor from the intake manifold, replace the MAP sensor to intake manifold seal.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step determines if DTC 34 is the result of a hard failure or an intermittent condition.
4. With the ECU connector disconnected and the voltage still present, this eliminates the ECU as the possible cause of the fault.
8. By jumping the 5 volt reference to the signal circuit, this step determines if the sensor is at fault, or if there is a problem with the circuit wiring.
9. The scan tool may not display 5 volts. The important thing is that the PCM recognized the voltage as more than 4 volts, indicating that the PCM and MAP signal are okay.

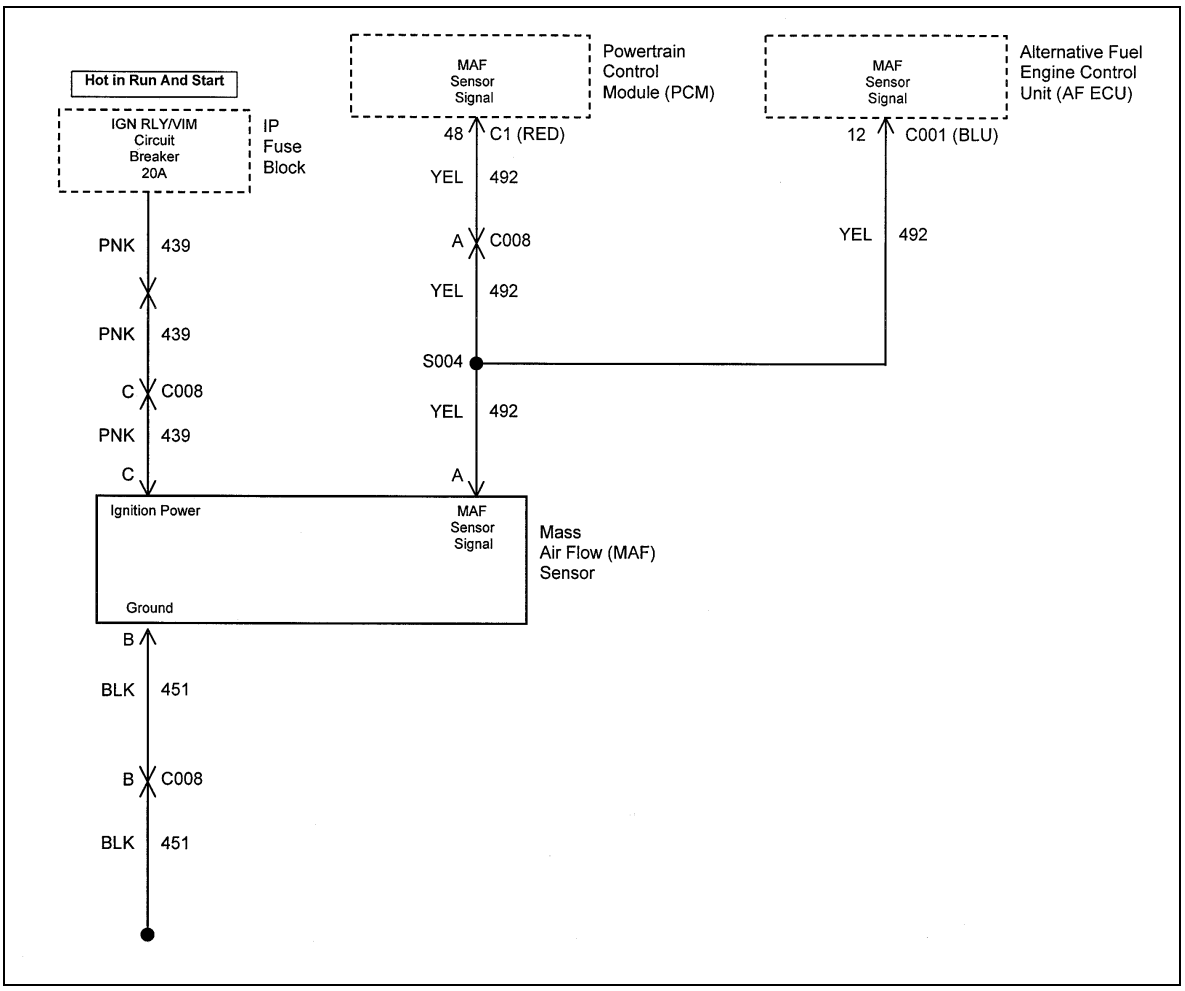
34 MAP Sensor Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Connect the scan tool. 2. Turn the ignition ON. Does the scan tool display a MAP sensor voltage less than the specified value?	0.10 V	Go to *Step 4*	Go to *Step 3*
3	Using a DVOM, backprobe the MAP sensor signal in the ECU connector. Does the DVOM display the MAP sensor signal less than the specified value?	0.098 V	Go to *Step 4*	Go to *Step 10*
4	1. Turn OFF the ignition. 2. Disconnect ECU connector C001. 3. Turn ON the ignition. Does the scan tool display a MAP sensor voltage less than the specified value?	0.10 V	Go to *Step 8*	Go to *Step 5*
5	1. Turn OFF the ignition. 2. Disconnect the MAP sensor connector. 3. Check for continuity of the MAP sensor signal circuit between the MAP and ECU connector. Is there continuity?	—	Go to *Step 6*	Go to *Step 16*
6	Inspect the ECU connector for loose, corroded or damaged pins. Was a problem found?	—	Go to *Step 16*	Go to *Step 7*

Step	Action	Value(s)	Yes	No
7	Replace the ECU. Refer to *ECU Replacement.* Is the action complete	—	Go to *Step 18*	—
8	1. Turn OFF the ignition. 2. Disconnect the MAP sensor electrical connector. 3. Connect a jumper wire between the MAP sensor 5 volt reference circuit and the MAP sensor signal circuit. 4. Turn ON the ignition leaving the engine OFF. Does the scan tool display a MAP sensor voltage near the specified value?	5.0 V	Go to *Step 11*	Go to *Step 9*
9	1. Turn OFF the ignition. 2. Remove the jumper wire. 3. Probe terminal B of the MAP sensor harness with a test lamp to B+. 4. Turn ON the ignition. Does the scan tool display a MAP sensor voltage near the specified value?	5.0 V	Go to *Step 14*	Go to *Step 12*
10	The DTC is intermittent. If no additional DTCs are stored, refer to Diagnosis Aids. If additional DTCs are stored, refer to those tables. Are any additional DTCs set?	—	Go to the Applicable DTC Table	Go to *Diagnostic Aids*
11	Check for a faulty connection at the MAP sensor. Was a problem found?	—	Go to *Step 16*	Go to *Step 15*
12	Check for an open MAP signal circuit. Was a problem found?	—	Go to *Step 16*	Go to *Step 13*
13	Check the MAP sensor signal circuit for a short to ground. Was a problem found?	—	Go to *Step 16*	Go to *Step 17*
14	Check for an open in the MAP sensor 5 volt reference circuit. Was a problem found?	—	Go to *Step 16*	Go to *Step 17*
15	Replace the MAP sensor. Is the action complete?	—	Go to *Step 18*	—
16	Repair the circuit as necessary. Is the action complete?	—	Go to *Step 18*	—

Step	Action	Value(s)	Yes	No
17	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the replacement complete?	—	Go to *Step 18*	—
18	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light still illuminates. Did the diagnostic run and pass?	—	Go to *Step 19*	Go to *Step 2*
19	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC Table	System OK

DTC 36 MAF Sensor Circuit Low Frequency



Circuit Description

The Mass Air Flow (MAF) sensor measures the amount of air entering the engine during a given time. The ECU uses the MAF information for fuel delivery calculations. A large quantity of air entering the engine indicates an acceleration or high load situation. A small quantity of air indicates deceleration or idle.
This MAF sensor produces a frequency signal that can be monitored using a scan tool. The frequency varies within a range of around 5 to 10 g/s at idle.
This DTC sets if the signal from the MAF sensor measurers below the possible range of a normally operating MAF sensor.
This DTC is a type A DTC.

Conditions for Setting the DTC

Cranking Test
- The engine is cranking.
- The battery voltage is greater than 8 volts.
- MAF frequency is below 125 Hertz (1 g/s) for 0.5 second.

Running Low Frequency Test
- Engine run time is greater than 10 seconds.
- Battery voltage is greater than 10 volts.
- Engine is running at greater than 500 RPM.
- MAF frequency is below 1.33 kHz (2.43 g/s) for 0.5 second.

Action Taken When the DTC Sets

If a MAF low input fault is detected, the ECU will set DTC 36 and illuminate the MIL light after 1 fault has occurred.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
Check for the following conditions:

- A poor connection at the ECU or MAF sensor. Inspect harness connectors for the following conditions:
  - Backed out terminals.
  - Improper mating.
  - Broken locks.
  - Improperly formed or damaged terminals.
  - Poor terminal to wire connection.
- A mis-routed harness. Inspect the MAF sensor harness in order to ensure it is not routed too close to high voltage wires such as spark plug leads.
- A damaged harness. Inspect the wiring harness for damage. If the harness is OK, observe the scan tool while moving the connectors and the wiring harnesses related to the MAF sensor. A change in the display indicates the location of the fault.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies the problem is present at idle.
11. A voltage reading of less than 4 volts or over 6 volts at the MAF signal circuit indicates a fault in the wiring or a poor connection.
12. This step verifies that the ignition feed circuit voltage and a good ground are available at the MAF sensor.

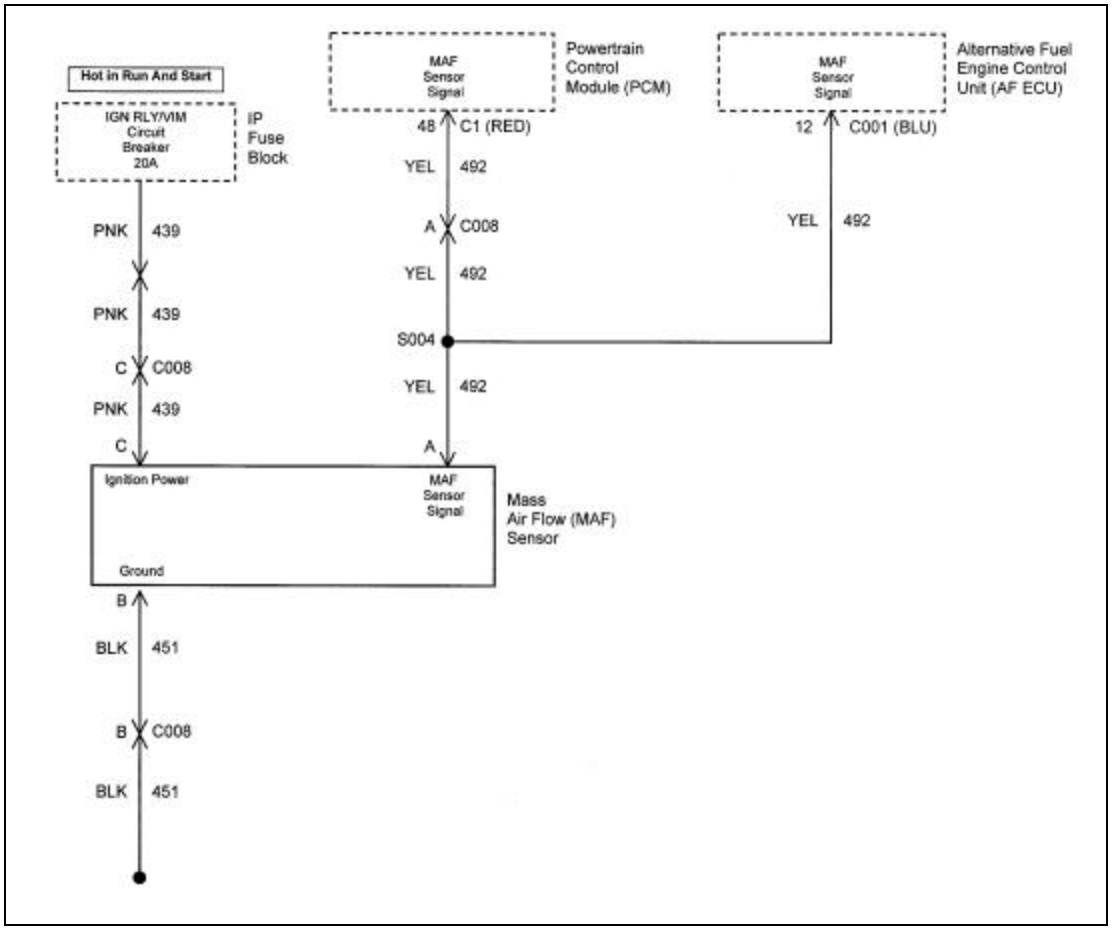
DTC 36 MAF Sensor Circuit Low Frequency

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Start the engine. 2. With the engine idling, monitor the MAF frequency display on the scan tool. Is the MAF frequency below the specified value?	2 g/s	Go to *Step 10*	Go to *Step 3*
3	1. Using a DVOM set to read frequency, back-probe the MAF circuit in the ECU connector. 2. With the engine idling, monitor the MAF circuit frequency on the DVOM. Is the MAF frequency below the specified value?	1.33 kHz	Go to *Step 5*	Go to *Step 4*
4	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light illuminates. Did the MIL illuminate?	—	Go to *Step 7*	Go to *Diagnostic Aids*
5	1. Turn OFF the engine. 2. Disconnect ECU connector C003. 3. Start the engine. 4. With the engine idling, monitor the MAF frequency display on the DVOM. Is the MAF frequency below the specified value?	2 g/s	Go to *Step 6*	Go to *Step 8*

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the engine. 2. Disconnect the MAF sensor. 3. Using a DVOM, check the resistance of the MAF circuit between the connectors. Is the resistance below the specified value?	0.4Ω	Go to *Step 10*	Go to *Step 18*
7	1. Disconnect the MAF sensor. 2. Disconnect ECU connector C003. 3. Using a DVOM, check the resistance of the MAF circuit between the connectors. Is the resistance below the specified value?	0.4Ω	Go to *Step 8*	Go to *Step 18*
8	1. Check for a poor connection at the MAF sensor. 2. Check for a poor connection at the ECU connector. 3. If a poor connection is found, replace the faulty terminal. Did you find a poor connection?	—	Go to *Step 18*	Go to *Step 9*
9	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 21*	—
10	1. Check for the following conditions: • Objects blocking the throttle body inlet screen. • Vacuum leaks in the intake manifold. • Vacuum leaks in the throttle body. • Vacuum leaks in the EGR flange and pipes. The crankshaft ventilation valve for being faulty, missing, or incorrectly installed. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *Step 21*	Go to *Step 11*
11	1. Turn OFF the ignition. 2. Disconnect the MAF sensor connector. 3. Turn ON the ignition, leaving the engine OFF. 4. Using a DVOM, measure the voltage between the MAF signal circuit and battery ground. Is the voltage near the specified value?	5.0 V	Go to *Step 12*	Go to *Step 15*
12	Connect a test lamp between the MAF sensor ignition feed and ground circuits at the MAF sensor harness connector. Is the test lamp on?	—	Go to *Step 14*	Go to *Step 13*
13	Connect a test lamp between the MAF sensor ignition feed circuit and the battery ground. Is the test lamp on?	—	Go to *Step 16*	Go to *Step 17*

Step	Action	Value(s)	Yes	No
14	1. Check for a poor connection at the MAF sensor. 2. If a poor connection is found, replace the faulty terminal. Did you find a poor connection?	—	Go to *Step 21*	Go to *Step 19*
15	1. Check the MAF signal circuit between the PCM and the MAF sensor for an open, short to ground, or a short to the MAF sensor ground circuit. 2. If the MAF signal circuit is open or shorted, repair as necessary. Refer to Wiring Repairs in Engine Electrical. Was the MAF signal circuit open or shorted?	—	Go to *Step 21*	Go to *Step 20*
16	1. Locate the open in the ground circuit to the MAF sensor. 2. Repair the open in the ground circuit to the MAF sensor. Is the action complete?	—	Go to *Step 21*	—
17	1. Locate the open in the ignition feed circuit to the MAF sensor. 2. Repair the open in the ignition feed circuit to the MAF sensor. Is the action complete?	—	Go to *Step 21*	—
18	The MAF sensor circuit to the ECU is open or has high resistance, repair as necessary. Is the action complete?	—	Go to *Step 21*	—
19	Replace the MAF sensor. Is the action complete?	—	Go to *Step 21*	—
20	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	Go to *Step 21*	—
21	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light still illuminates. Did the diagnostic run and pass?	—	Go to *Step 22*	Go to *Step 2*
22	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC Table	System OK

DTC 37 MAF Sensor Circuit High Frequency



Circuit Description

The Mass Air Flow (MAF) sensor measures the amount of air entering the engine during a given time. The ECU uses the MAF information for fuel delivery calculations. A large quantity of air entering the engine indicates an acceleration or high load situation. A small quantity of air indicates deceleration or idle.
This MAF sensor produces a frequency signal that can be monitored using a scan tool. The frequency varies within a range of around 5 to 10 g/s at idle. This DTC sets if the signal from the MAF sensor measures above the possible range of a normally operating MAF sensor. This DTC is a type A DTC.

Conditions for Setting the DTC

Ignition On Engine Off Test

- Ignition is ON and the engine is OFF.
- Battery voltage is greater than 10 volts.
- MAF frequency is greater than 10.39 kHz (331 g/s) for 0.5 second.

Cranking Test

- Engine is cranking.
- The battery voltage is greater than 8 volts.
- MAF frequency is greater than 10.39 kHz (331 g/s) for 0.5 second.

Running High Frequency Test

- Engine run time is greater than 10 seconds.
- Battery voltage is greater than 10 volts.
- Engine is running at greater than 500 RPM.
- MAF frequency is greater than 10.39 kHz (331 g/s) for 0.5 second.

Action Taken When the DTC Sets

If a MAF high input fault is detected, the ECU will set DTC 37 and illuminate the MIL light after 1 fault has occurred.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant

temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure. Check for the following conditions:

- A poor connection at the ECU or MAF sensor. Inspect harness connectors for the following conditions:
  - Backed out terminals.
  - Improper mating.
  - Broken locks.
  - Improperly formed or damaged terminals.
  - Poor terminal to wire connection.
- A mis-routed harness. Inspect the MAF sensor harness in order to ensure it is not routed too close to high voltage wires such as spark plug leads.
- A damaged harness. Inspect the wiring harness for damage. If the harness appears to be okay, observe the scan tool while moving the connectors and the wiring harnesses related to the MAF sensor. A change in the display indicates the location of the fault.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step verifies that the problem is present at idle.
9. A frequency reading with the MAF sensor connector disconnected indicates an Electromagnetic Interference (EMI) related fault or a poor connection.

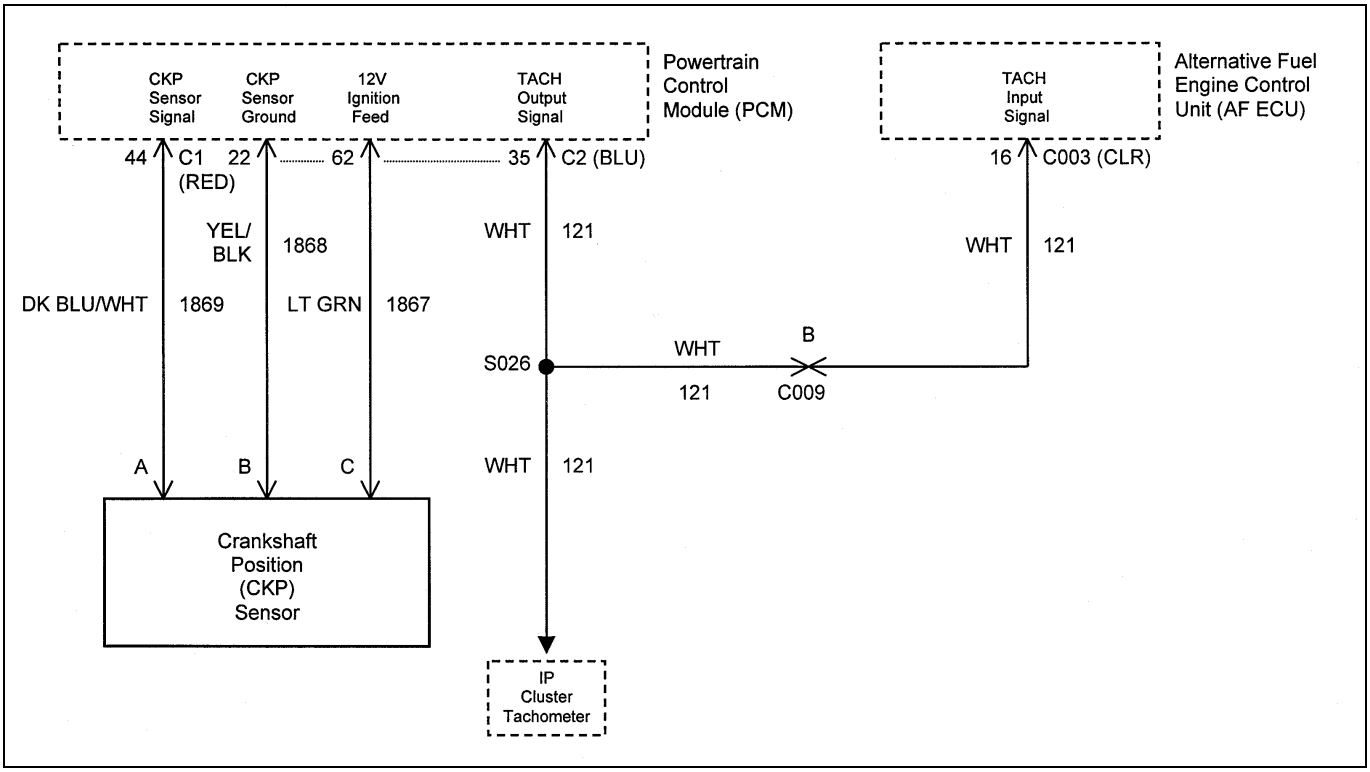
DTC 37 MAF Sensor Circuit High Frequency

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Install a scan tool. 2. Start the engine. 3. With the engine idling, monitor the MAF frequency display on the scan tool. Is the MAF frequency above the specified value?	11 kHz	Go to *Step 7*	Go to *Step 3*
3	1. Backprobe the MAF circuit in the ECU connector using a DVOM set to read frequency. 2. Monitor the MAF circuit frequency on the DVOM with the engine idling. Is the MAF frequency above the specified value?	10.39 kHz	Go to *Step 7*	Go to *Step 4*
4	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL light illuminates. Did the MIL illuminate?	—	Go to *Step 5*	Go to *Diagnostic Aids*
5	1. Turn OFF the engine. 2. Disconnect ECU connector C003. 3. Turn the ignition ON leaving the engine OFF. 4. Monitor the MAF frequency display on the DVOM with the engine idling. Is the MAF frequency above the specified value?	10.39 kHz	Go to *Step 7*	Go to *Step 6*

Step	Action	Value(s)	Yes	No
6	1. Check for a poor connection at the ECU connector. 2. If a poor connection is found, replace the faulty terminal. Did you find a poor connection?	—	Go to *Step 14*	Go to *Step 12*
7	1. Turn OFF the ignition. 2. Disconnect the MAF sensor connector. 3. Start the engine and allow it to idle. 4. Monitor the MAF frequency using a scan tool. Does the Scan Tool indicate a MAF sensor frequency?	—	Go to *Step 8*	Go to *Step 9*
8	1. Check for a poor connection at the MAF Sensor harness terminals. 2. If a poor connection is found, replace the faulty terminals. Was a poor connection found?	—	Go to *Step 14*	Go to *Step 9*
9	1. Perform the following MAF Sensor harness checks for incorrect routing: • Near the secondary ignition wires or coils. • Near the other high voltage components (solenoids, relays, motors). 2. If an incorrect routing is found, correct the harness routing. Was a problem found?	—	Go to *Step 14*	Go to *Step 11*
10	Replace the MAF Sensor. Is the action complete?	—	Go to *Step 14*	—
11	1. Check the MAF signal circuit terminal connections at the PCM. 2. If a poor connection is found, repair as necessary. Was a poor connection found?	—	Go to *Step 14*	Go to *Step 13*
12	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 14*	—
13	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the replacement complete?	—	Go to *Step 14*	—

Step	Action	Value(s)	Yes	No
14	1. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 2. Check to see if the MIL still illuminates. Did the diagnostic run and pass?	—	Go to *Step 15*	Go to *Step 2*
15	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to Applicable DTC Table	System OK

DTC 41 CKP Sensor Circuit Performance



Circuit Description

The Crankshaft Position (CKP) sensor sends a reference signal to the Engine Control Unit (ECU) in order to indicate the engine RPM . Loss of this signal or intermittent operation of the CKP sensor will set DTC 41.
This may trigger an ECU DTC before a PCM DTC as the AF ECU is slightly more sensitive to a marginal CKP sensor. This DTC is a type A DTC.

Conditions for Setting the DTC

- None of the following DTCs are active: 36, 37.
- MAF is detecting greater than 3 g/s and no RPM signal has been received.

Action Taken When the DTC Sets

If a CKP input fault is detected, the ECU will set DTC 41 and illuminate the MIL light after 1 fault has occurred.

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
A faulty or disconnected Mass Air Flow Sensor (MAF) may create a condition that will set a false DTC 41 verify operation and connection of the MAF prior to performing this diagnostic procedure.

Check for the following conditions:

- A poor connection, a rubbed through wire insulation, or a wire that is broken inside the insulation may cause an intermittent problem.
- Inspect harness connectors for the following conditions:
  - Backed out terminals.
  - Improper mating.
  - Broken locks.
  - Improperly formed or damaged terminals.
  - Poor terminal to wire connection.
- - Physical damage to the wiring harness.

Inspect the face of the CKP sensor for metal shavings. This could result in an intermittent DTC. Refer to *Intermittents* in the powertrain diagnostics manual.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

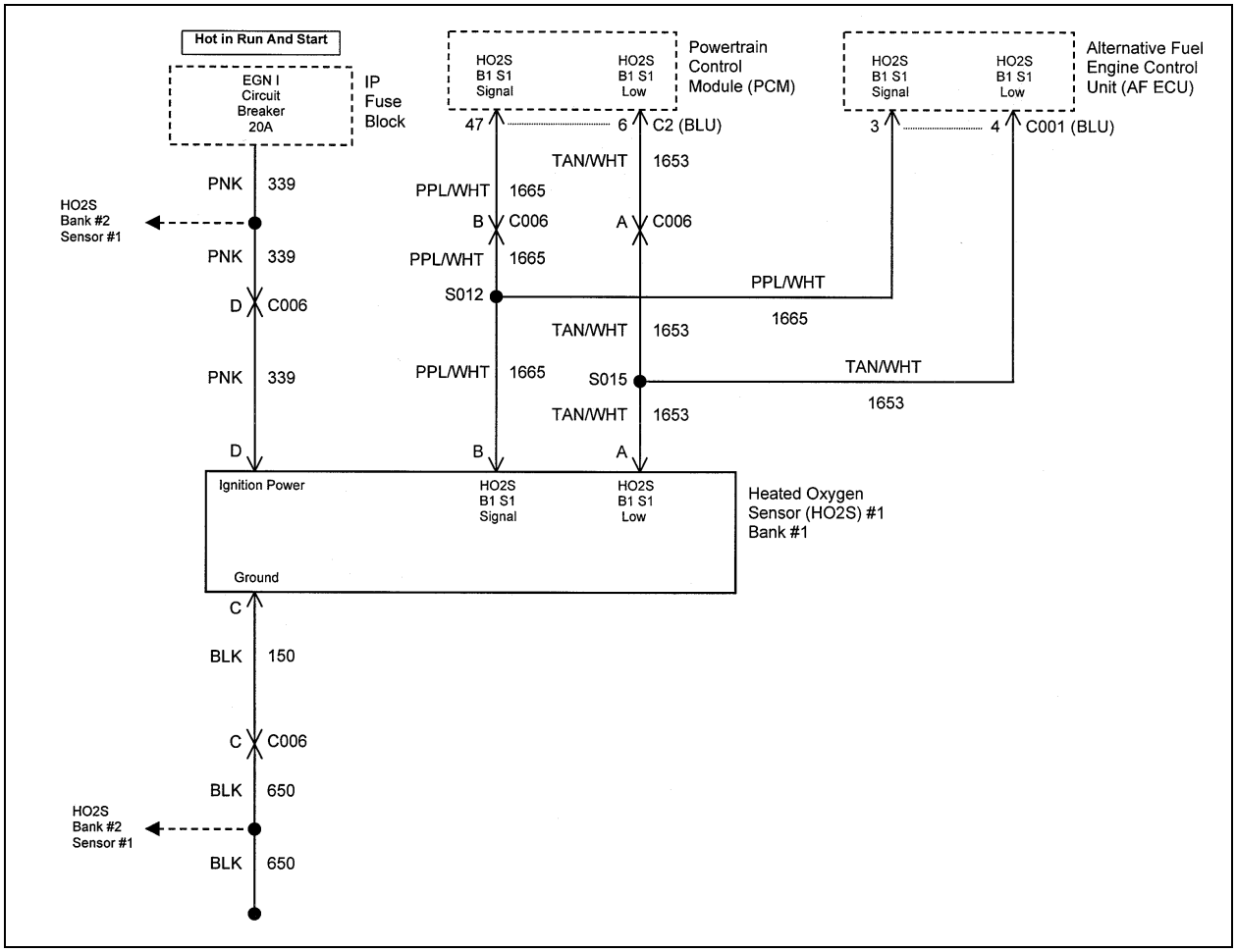
2. This step determines if the DTC 41 is the result of a hard failure or an intermittent condition.
3. This step determines if the ECU is receiving the Crankshaft Position sensor pulses.
6. This step checks the CKP sensor signal circuit for any unusual loading conditions. If the ECU is not receiving a signal and no circuit faults can be found. The PCM is not outputting a tachometer signal and should be diagnosed.

DTC 41 CKP Sensor Circuit Performance

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	Start the vehicle. Does the vehicle start and continue to run?	—	Go to *Diagnostic Aids*	Go to *Step 3*
3	1. Turn OFF the ignition. 2. Backprobe CKP sensor circuit at ECU connector C003. 3. Connect a DVOM set to read AC voltage between the CKP sensor signal circuit and a known good ground. 4. Crank the engine. Is voltage detected while the engine is cranking?	—	Go to *Step 5*	Go to *Step 4*
4	1. Turn OFF the ignition. 2. Disconnect the PCM connector. 3. Disconnect ECU connector C003. 4. Using a DVOM, check for continuity of the CKP sensor signal circuit between the PCM and ECU. Was a problem found?	—	Go to *Step 8*	Go to *Step 6*
5	1. Clear the DTC. 2. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 3. Check to see if the MIL still illuminates. Did the diagnostic run and pass?	—	Go to *Diagnostic Aids*	Go to *Step 7*
6	1. Check for a short to ground or short to ignition power in the CKP signal circuit. 2. Check for a load on the CKP signal circuit (malfunctioning tachometer). 3. Check for proper pin tension at the PCM connector. Was a problem found and repaired?	—	Go to *Step 10*	Go to *DTC PO336 CKP Sensor Circuit Performance* in the GM MD Service Manual
7	Inspect the ECU connector and pins. Was a problem found?	—	Go to *Step 8*	Go to *Step 9*

Step	Action	Value(s)	Yes	No
8	Repair the open or damaged circuit. Is the action complete?	—	Go to *Step 10*	—
9	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 10*	—
10	1. Clear the DTC. 2. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. 3. Check to see if the MIL still illuminates. Did the diagnostic run and pass?	—	Go to *Step 11*	Go to *Step 2*
11	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC 42 HO2S Insufficient Activity Bank 1 Sensor 1



Circuit Description

The PCM supplies a bias voltage of about 0.45 volt between the HO2S high and HO2S low circuits. The Heated Oxygen Sensor (HO2S Bank 1 Sensor 1) varies the voltage within the range of about 1.0 (1000 mV) volt if the exhaust is rich, down to about 0.1 (100 mV) volt if the exhaust is lean.
The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F). This will result in Open Loop operation.
The HO2S heater provides for a faster sensor warm-up, which allows the sensor to become active in a shorter period of time and remain active during a long extended idle.
DTC 42 determines if the HO2S or the HO2S circuit has developed an open. This DTC is a type B DTC.

Conditions for Setting the DTC

- Engine speed is greater than 500 RPM.
- Engine run time is greater than 120 seconds.
- The oxygen sensor has been warm for at least 100 seconds. The oxygen sensor is determined to be warm by the ECU if ECT is greater than 40°C (104°F) and the mass air flow is above 17 g/s for at least 100s.
- The HO2S sensor showed no rich/lean activity for longer than 15 seconds.

Action Taken When the DTC Sets

The MIL will be turned on after 2 consecutive trips with test failures. The system will operate in “Open Loop” if any DTC of the second HO2S (Bank 2 Sensor 1) is set (DTC 63,64 or 65).

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
A poor connection, rubbed through wire insulation, or a wire broken inside the insulation may cause an intermittent.
Check the following conditions:

- A poor connection or a damaged harness - Check for the following conditions:
- Backed out terminals
- Improperly formed or damaged terminals
- Poor terminal to wire connection
  - Damaged harness
- A poor ECU to the engine block ground.
- Faulty Fuel Control Solenoid (FCS).
- Faulty Regulator Control Valve (RCV).
- Faulty Low Pressure Regulator.
- Exhaust leaks: If there is an exhaust leak, the engine may pull the outside air into the exhaust and past the sensor.
- Vacuum or crankcase leaks can cause a lean condition or possibly a high idle.
- If the above check out okay, the problem may be a faulty heated sensor.
- A faulty HO2S (Bank 1, Sensor 1) heater or heater circuit. With the ignition switch on but the engine off, the HO2S (Bank 1, Sensor 1) voltage displayed on a scan tool should gradually drop to below 0.150 volt, indicating that the heater works properly.
  If not, disconnect the HO2S (Bank 1, Sensor 1) and connect a test lamp between the terminals *"C" and "D"*. If the test lamp does not light, repair the open in the HO2S (Bank 1, Sensor 1) ground circuit or the HO2S (Bank 1, Sensor 1) ignition feed circuit. If the test lamp lights, replace the HO2S (Bank 1, Sensor 1).
- The intermittent test - With a scan tool, monitor the HO2S (Bank 1, sensor 1) signal voltage while moving the related connectors and the wiring harness with a warm engine running at part throttle in closed loop. If the failure is induced, the HO2S (Bank 1, Sensor 1) signal voltage reading changes from its normal fluctuating voltage (above 600 mV and below 300 mV) to a fixed value around 450 mV. This may help isolate the location of the malfunction.
- Never solder the HO2S wires. For proper wire and connector repair, refer to Wiring Repairs in Engine Electrical.

Test Description

The number(s) below refer to the step numbers on the diagnostic table.

2. This test will indicate if the fault is still present, if the fault is not present operate the vehicle at different engine speeds and loads.
4. This test determines if the ECU is the cause of DTC 42.
10. This test will verify operation of the fuel control valves. If the pressure reading is fluctuating, this indicates proper operation of the fuel control valves. The fuel control valves may function at one operating condition and fail at another, operate the vehicle at varying engine speeds and loads to check for this condition.

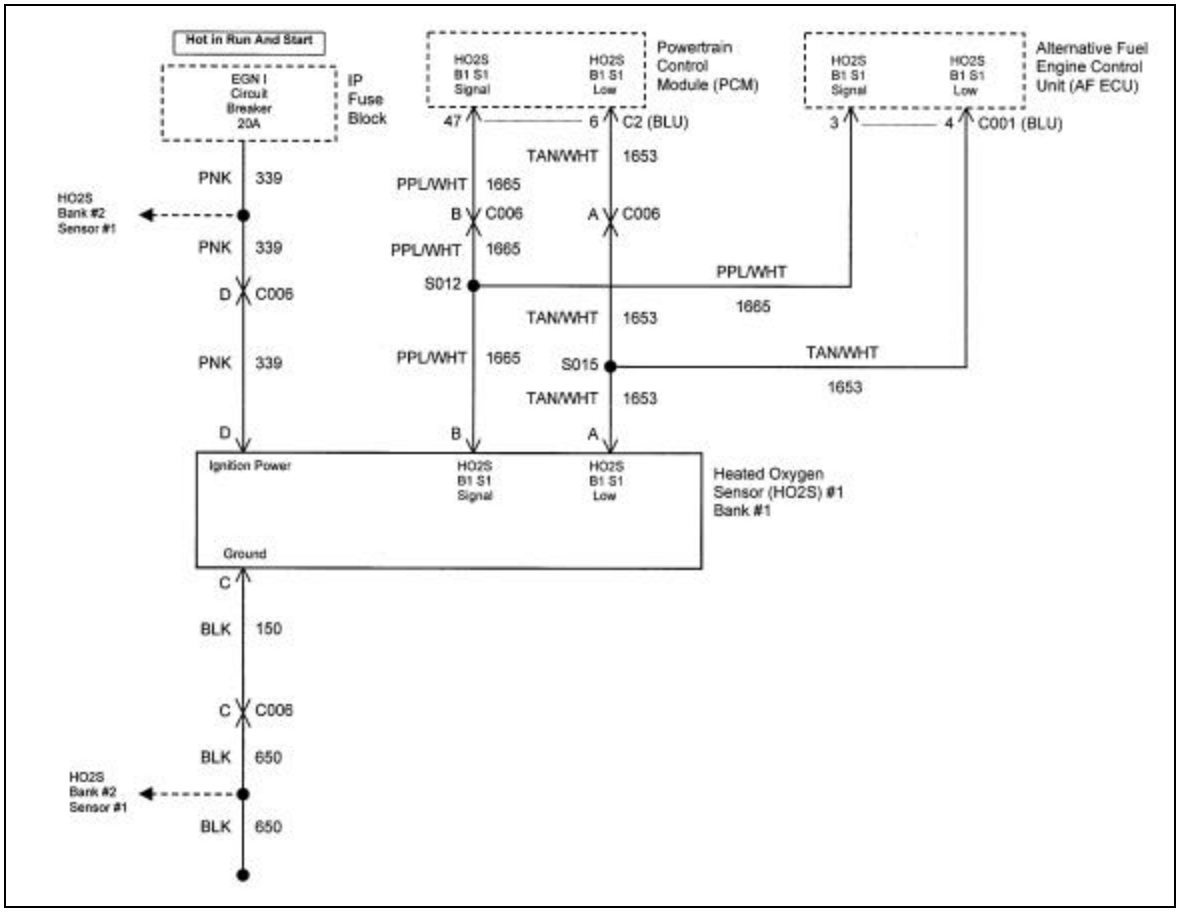
DTC 42 HO2S Insufficient Activity Bank 1 Sensor 1

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	**Go to *AF Powertrain OBD System Check***
2	1. Install a scan tool. 2. Idle the engine at normal operating temperature. 3. Operate the engine above 1200 RPM for two minutes. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage varying outside the specified range?	300 mV to 600 mV	Go to *Step 13*	Go to *Step 3*
3	1. Disconnect the HO2S (Bank 1, Sensor 1) sensor electrical connector. 2. Install a jumper between the HO2S (Bank 1, Sensor 1) harness high and low (PCM side) signal circuits. 3. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage less than the specified value?	200 mV	Go to *Step 7*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage less than the specified value?	200 mV	Go to *Step 14*	Go to *Step 5*
5	1. Remove the jumper wire. 2. Using a DVOM, measure the voltage between the bank 1 HO2S 1 high signal circuit and a known good ground. Is the voltage within the specified range?	375 mV to 525 mV	Go to *Step 6*	Go to *Step 8*
6	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 1 HO2S 1 signal low circuit between the PCM and the HO2S connector. 3. Check the bank 1 HO2S 1 low circuit for a short to ignition power or ground. Was a problem found?	—	Go to *Step 17*	Go to *Step 16*

Step	Action	Value(s)	Yes	No
7	1. Remove the jumper wire. 2. Using a DVOM, measure the voltage between the bank 1 HO2S 1 high signal circuit and a known good ground. Is the voltage within the specified range?	375 mV to 525 mV	Go to *Step 9*	Go to *Step 8*
8	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 1 HO2S 1 signal high circuit between the PCM and the HO2S connector. 3. Check the bank 1 HO2S 1 high circuit for a short to ignition power or ground. Was a problem found?	—	Go to *Step 17*	Go to *Step 16*
9	1. Check for a poor terminal connection at the bank 1 HO2S 1 connector. Check all connector circuit connections for loose terminal tension. 2. Install a test lamp between the bank 1 HO2S 1 heater high and low circuits, the test lamp should illuminate. Was a problem found?	—	Go to *Step 17*	Go to *Step 10*
10	1. Reconnect the HOS2 connector. 2. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator. 3. Start the engine. 4. Observe the pressure gauge in the secondary test port. Is the fuel pressure reading steady?	—	Go to *AF Fuel System Diagnosis*	Go to *Step 11*
11	1. Check for engine vacuum leakage. Repair any leaks that are found. 2. Check for exhaust system leakage upstream of the sensor. Repair any leaks that are found. Was a problem found and repaired?	—	Go to *Step 19*	Go to *Step 12*
12	Replace the bank 1 HO2S 1. Is the action complete?	—	Go to *Step 19*	—
13	The DTC is intermittent. Are there any Powertrain DTCs displayed that have not been diagnosed?	—	Go to the applicable Powertrain DTC table	Go to *Diagnostic Aids*
14	Check for a poor connection at the ECU. Was a problem found?	—	Go to *Step 17*	Go to *Step 15*
15	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 19*	—

Step	Action	Value(s)	Yes	No
16	Check for a faulty or loose connection at the PCM connector. Was a problem found?	—	Go to *Step 17*	Go to *Step 18*
17	Repair the circuit as necessary. Is the action complete?	—	Go to *Step 19*	—
18	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	*Go to Step 19*	—
19	1. Bring the engine up to normal operating temperature. 2. Run the engine above the specified value for at least 4 minutes. 3. Turn OFF the engine and the ignition for at least 10 seconds 4. Run the engine above the specified value for at least 4 minutes (second time). Did the MIL illuminate?	1500 RPM	Go to *Step 2*	System OK

DTC 44 HO2S Circuit Low Voltage Bank 1 Sensor 1



Circuit Description

The ECU supplies a voltage of about 0.45 volt between the HO2S high and HO2S low circuits. The Heated Oxygen Sensor (HO2S Bank 1 Sensor 1) varies the voltage within the range of about 1.0 (1000 mV) volt if the exhaust is rich, down to about 0.1 (100 mV) volt if the exhaust is lean.
The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F). DTC 44 determines if the HO2S sensor or the circuit is shorted to low by checking for an extended lean condition. This DTC is a type B DTC.

Conditions for Setting the DTC

- The engine is running at greater than 500 RPM.
- The ECT is greater than 70°C (160°F).
- The oxygen sensor has been warm for at least 120 seconds (The oxygen sensor is determined to be warm by the ECU if ECT is greater than 40°C (104°F) and the mass air flow is above 17 g/s for at least 120s).
- The ECU is in closed loop operation.
- The HO2S (Bank 1 Sensor 1) voltage is less than (0.02 volt) 20 mV.

Action Taken When the DTC Sets

The MIL will be turned on after 2 consecutive trips with test failures. The system will operate in Open Loop if any DTC of the second HO2S (Bank 2 Sensor 1) is set (DTC 63, 64 or 65).

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
Check the following conditions:

- A heated oxygen sensor wire: A sensor pigtail may be mis-routed and contacting the exhaust manifold.
- An intermittent ground in the wire between the connector and the sensor.
- A poor ECU to the engine block ground.
- If the above check out okay, the problem may be a faulty heated sensor.

Never solder the HO2S wires. For proper wire and connector repair, refer to *Wiring Repairs* in Engine Electrical in the appropriate GM MD Service Manual.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step will determine if the fault is currently present.
3. This step will determine if the HO2S is shorted and the cause of the fault.
4. This step will determine if the AF ECU is the cause of the fault.
5. This test determines if the sensor wiring is the cause of the DTC 44.

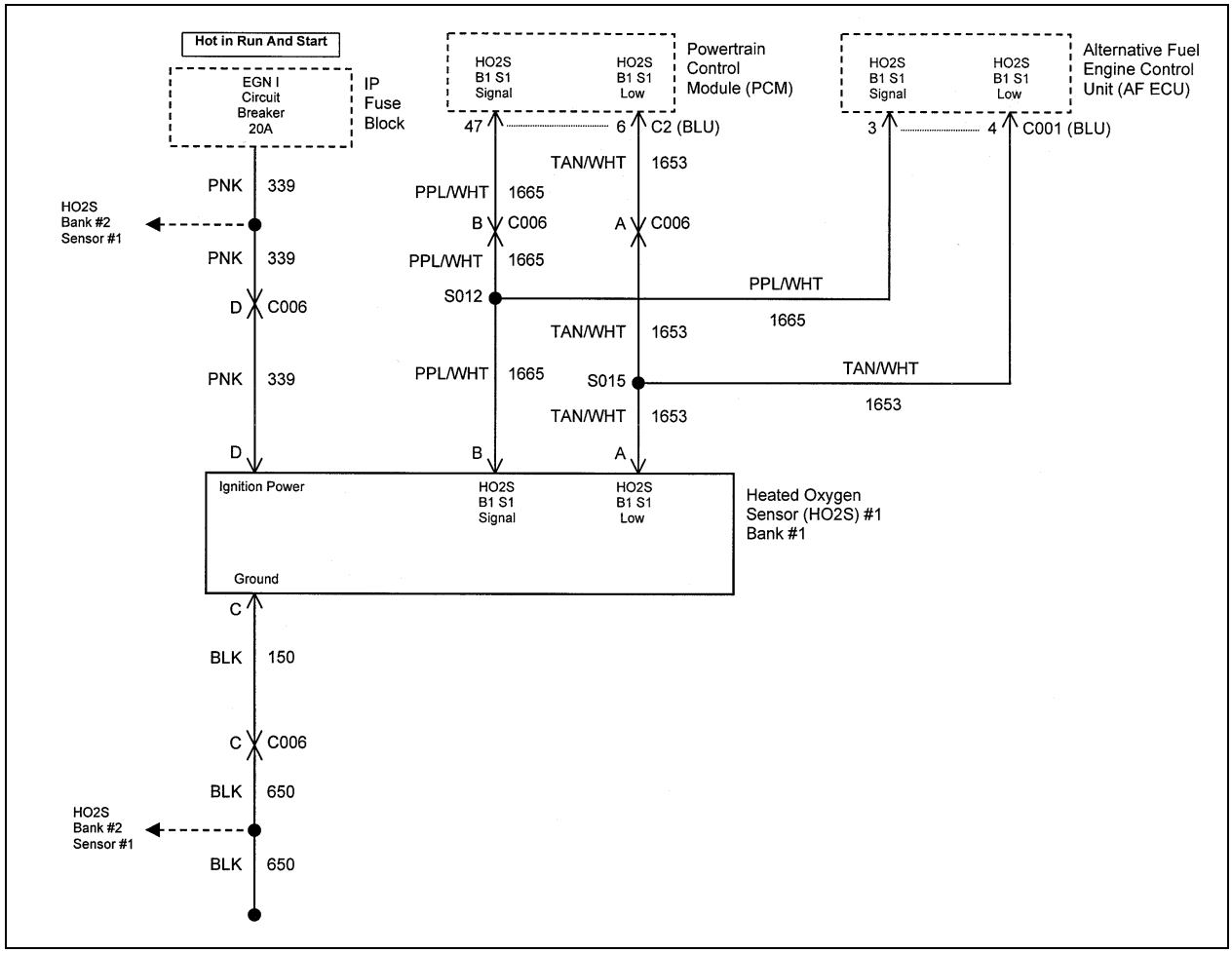
DTC 44 HO2S Circuit Low Voltage Bank 1 Sensor 1

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Install a scan tool. 2. Idle the engine at normal operating temperature. 3. Operate the engine above 1200 RPM for two minutes. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage varying outside the specified range?	300 mV to 600 mV	Go to *Step 8*	Go to *Step 3*
3	1. Disconnect the HO2S (Bank 1, Sensor 1) sensor electrical connector. 2. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage is within the specified range?	350 mV to 550 mV	*Go to Step 6*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage within the specified range?	350 mV to 550 mV	Go to *Step 9*	Go to *Step 5*

Step	Action	Value(s)	Yes	No
5	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 1 HO2S 1 signal high circuit between the PCM, ECU and the HO2S connector. 3. Check the bank 1 HO2S 1 high circuit for a short to voltage or ground. Was a problem found?	—	Go to *Step 12*	Go to *Step 11*
6	1. Check for a poor terminal connection at the bank 1 HO2S 1 connector. Check all circuits for loose terminal tension. 2. Install a test lamp between the bank 1 HO2S 1 heater high and low circuits, the test lamp should illuminate. Was a problem found?	—	Go to *Step 12*	Go to *Step 7*
7	Replace the bank 1 HO2S 1. Is the action complete?	—	Go to *Step 14*	—
8	The DTC is intermittent. Are there any Powertrain DTCs displayed that have not been diagnosed?	—	Go to the applicable Powertrain DTC table	Go to *Diagnostic Aids*
9	Check for a poor connection at the ECU. Was a problem found?	—	Go to *Step 12*	Go to *Step 10*
10	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 14*	—
11	Check for a faulty or loose connection at the PCM connector. Was a problem found?	—	Go to *Step 12*	Go to *Step 13*
12	Repair the circuit as necessary. Is the action complete?	—	Go to *Step 14*	—
13	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming.* The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	Go to *Step 14*	—

Step	Action	Value(s)	Yes	No
14	1. Bring the engine up to normal operating temperature. 2. Run the engine above the specified value for at least 4 minutes. 3. Turn OFF the engine and the ignition for at least 10 seconds 4. Run the engine above the specified value for at least 4 minutes (second time). Did the MIL illuminate?	1500 RPM	Go to *Step 2*	System OK

DTC 45 HO2S Circuit High Voltage Bank 1 Sensor 1



Circuit Description

The ECU supplies a voltage of about 0.45 volt between the HO2S high and HO2S low circuits. The Heated Oxygen Sensor (HO2S Bank 1 Sensor 1) varies the voltage within the range of about 1.0 volt (1000 mV)if the exhaust is rich, down to about 0.1 (100 mV) volt if the exhaust is lean.
The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F).
DTC 45 determines if the HO2S sensor or the circuit is shorted to high by checking for an extended rich condition. This DTC is a type B DTC.

Conditions for Setting the DTC

- The engine is running at greater than 500 RPM.
- The ECT is greater than 70°C (160°F).
- The oxygen sensor has been warm for at least 120 seconds. The oxygen sensor is determined to be warm by the ECU if ECT is greater than 40°C (104°F) and the mass air flow is above 17 g/sec for at least 120s.
- The ECU is in closed loop operation.
- The HO2S (Bank 1 Sensor 1) voltage is greater than 1.0 volt.

Action Taken When the DTC Sets

The MIL will be turned on after 2 consecutive trips with test failures. The system will operate in Open Loop if any DTC of the second HO2S (Bank 2 Sensor 1) is set (DTC 63,64 or 65).

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure. Check the following items:

- Fuel pressure - The ECU can compensate for small increases in fuel pressure. However, large increases in fuel pressure may set a DTC.
- Faulty Fuel Control Solenoid (FCS).
- Vacuum leaks in the fuel control valve hoses.
- Faulty Regulator Control Valve (RCV).
- False rich indication due to silicon contamination of the HO2S. This will be accompanied by lean driveability conditions and a powdery white deposit on the sensor.
- Faulty HO2S (Bank 1 Sensor 1). If the HO2S (Bank 1 Sensor 1) is internally shorted, the HO2S (Bank 1 Sensor 1) voltage displayed will 10. be over 1V. Try disconnecting the HO2S (Bank 1 Sensor 1); if the displayed voltage goes from over 1000 mV to around 450 mV, replace HO2S (Bank 1 Sensor 1).
- Never solder the HO2S wires.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

6. This step will determine if the fault is currently present.
7. This step will determine if the HO2S is shorted and the cause of the fault.
8. This step will determine if the AF ECU is the cause of the fault.
9. This test determines if the sensor wiring is the cause of the DTC 45.

DTC 45 HO2S Circuit High Voltage Bank 1 Sensor 1

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Install a scan tool. 2. Idle the engine at normal operating temperature. 3. Operate the engine above 1200 RPM for two minutes. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage varying outside the specified range?	300 mV to 600 mV	Go to *Step 8*	Go to *Step 3*
3	1. Disconnect the HO2S (Bank 1, Sensor 1) sensor electrical connector. 2. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage is within the specified range?	350 mV to 550 mV	Go to *Step 6*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 1 HO2S 1 voltage within the specified range?	350 mV to 550 mV	Go to *Step 9*	Go to *Step 5*

Step	Action	Value(s)	Yes	No
5	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 1 HO2S 1 signal high circuit between the PCM, ECU and the HO2S connector. 3. Check the bank 1 HO2S 1 high circuit for a short to voltage or ground. 4. Check the bank 1 HO2S 1 low circuit for a short to voltage or ground. Was a problem found?	—	Go to *Step 12*	Go to *Step 11*
6	1. Check for a poor terminal connection at the bank 1 HO2S 1 connector. Check all circuits for loose terminal tension. 2. Install a test lamp between the bank 1 HO2S 1 heater high and low circuits, the test lamp should illuminate. Was a problem found?	—	Go to *Step 12*	Go to *Step 7*
7	Replace the bank 1 HO2S 1. Is the action complete?	—	Go to *Step 14*	—
8	The DTC is intermittent. Are there any Powertrain DTCs displayed that have not been diagnosed?	—	Go to the applicable Powertrain DTC table	Go to *Diagnostic Aids*
9	Check for a poor connection at the ECU. Was a problem found?	—	Go to *Step 12*	Go to *Step 10*
10	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 14*	—
11	Check for a faulty or loose connection at the PCM connector. Was a problem found?	—	Go to *Step 12*	Go to *Step 13*
12	Repair the circuit as necessary. Is the action complete?	—	Go to *Step 14*	—
13	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	Go to *Step 14*	—

Step	Action	Value(s)	Yes	No
14	1. Bring the engine up to normal operating temperature. 2. Run the engine above the specified value for at least 4 minutes. 3. Turn OFF the engine and the ignition for at least 10 seconds. 4. Run the engine above the specified value for at least 4 minutes (second time). Did the MIL illuminate?	1500 RPM	Go to *Step 2*	System OK

DTC 58 AF ECU Internal Failure

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
A poor connection, a rubbed through wire insulation, or a wire broken inside the insulation may cause an intermittent.

Check for the following conditions:

- A poor connection or damaged harness. Inspect the ECM harness connector for the following conditions:
  - Backed out terminals
  - Improper mating
  - Broken locks
  - Improperly formed or damaged terminals
  - Poor terminal to wire connection and
  - Damaged harness.

Multiple Stored Codes

Intermittent connections may cause the AF ECM to store multiple false codes. If the AF ECM has stored an excessive number of DTCs for no apparent reason, check the battery and ignition power and ground circuits to the AF ECM.

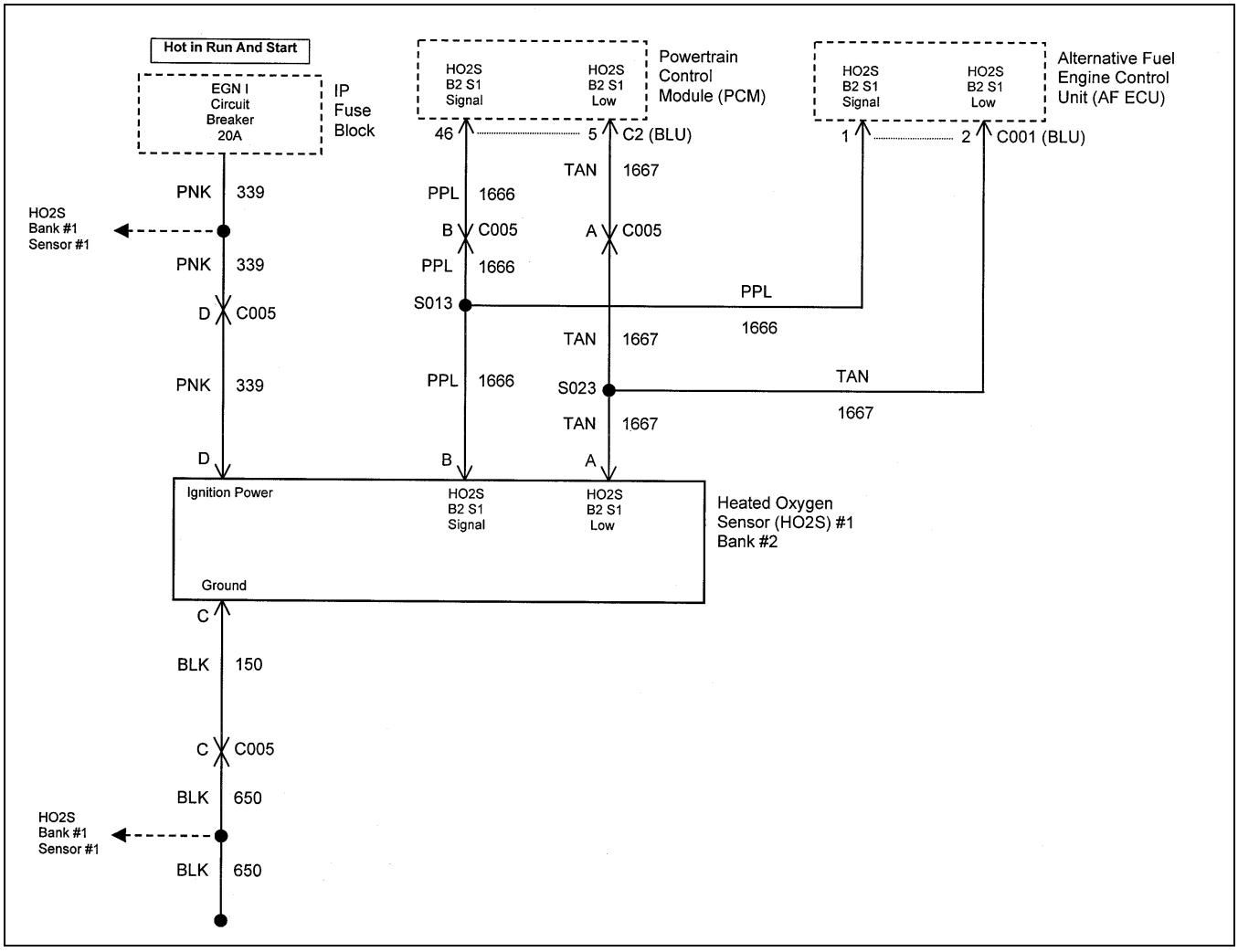
Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies battery power, ignition power and ground to the AF ECM.

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	Was DTC 58 retrieved from the AF ECU?	—	Go to *Step 3*	Go to *Step 5*
3	1. Check for proper connection of the ignition power and ground connections, verify that the connections are clean and tight. 2. Check loose or corroded connections at the ECU connector. Was a problem found and corrected?	—	Go to *Step 6*	Go to *Step 4*
4	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 5*	—
5	Were any other DTCs set in the ECU ?	—	Go to the applicable DTC table	System OK
6	1. Start and run vehicle. 2. Check to see if the MIL still illuminates. Did the diagnostic run and pass?	—	Go to *Step 7*	Go to *Step 2*
7	Are any ECU or PCM DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC 63 HO2S Insufficient Activity Bank 2 Sensor 1



Circuit Description

The ECU supplies a voltage of about 0.45 volt (450 mV) between the HO2S high and HO2S low circuits. The Heated Oxygen Sensor (HO2S Bank 2 Sensor 1) varies the voltage within the range of about 1.0 volt (1000 mV) if the exhaust is rich, down to about 0.10 volt (100 mV) if the exhaust is lean.
The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F). This will result in Open Loop operation.
The HO2S heater provides for a faster sensor warm-up, which allows the sensor to become active in a shorter period of time and remain active during a long extended idle.
DTC 63 determines if the HO2S at the HO2S circuit has developed an open. This DTC is a type B DTC.

Conditions for Setting the DTC

- Engine run time is greater than 120 seconds.
- Engine is running at greater than 500 RPM.
- The oxygen sensor has been warm for at least 120 seconds. The oxygen sensor is determined to be warm by the ECU if ECT is greater than 40°C (104°F) and the mass air flow above 17 g/s for at least 120s.
- The HO2S sensor showed no rich/lean activity for longer than 15 seconds.

Action Taken When the DTC Sets

The MIL will be turned on after 2 consecutive trips with test failures. The system will operate in Open Loop if any DTC of the second HO2S (Bank 1 Sensor 1) is set (DTC 42,44 or 45).

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature

exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
A poor connection, rubbed through wire insulation, or a wire broken inside the insulation may cause an intermittent.

Check the following conditions:

- A poor connection or a damaged harness - Check for the following conditions:
- Backed out terminals
- Improperly formed or damaged terminals
- Poor terminal to wire connection
  - Damaged harness
- A poor ECU to the engine block ground.
- Faulty Fuel Control Solenoid (FCS).
- Faulty Regulator Control Valve (RCV).
- Faulty Low Pressure Regulator.
- Exhaust leaks: If there is an exhaust leak, the engine may pull the outside air into the exhaust and past the sensor.
- Vacuum or crankcase leaks can cause a lean condition or possibly a high idle.
- If the above check out okay, the problem may be a faulty heated sensor.
- A faulty HO2S (Bank 2, Sensor 1) heater or heater circuit. With the ignition switch on but the engine off, the HO2S (Bank 2, Sensor 1) voltage displayed on a scan tool should gradually drop to below 0.150 volt, indicating that the heater works properly.
  If not, disconnect the HO2S (Bank 2, Sensor 1) and connect a test lamp between the terminals *"C" and "D"*. If the test lamp does not light, repair the open in the HO2S (Bank 2, Sensor 1) ground circuit or the HO2S (Bank 2, Sensor 1) ignition feed circuit. If the test lamp lights, replace the HO2S (Bank 2, Sensor 1).
- The intermittent test: With a scan tool, monitor the HO2S (Bank 2, sensor 1) signal voltage while moving the related connectors and the wiring harness with a warm engine running at part throttle in closed loop. If the failure is induced, the HO2S (Bank 2, Sensor 1) signal voltage reading changes from its normal fluctuating voltage (above 600 mV and below 300 mV) to a fixed value around 450 mV. This may help isolate the location of the malfunction.
- Never solder the HO2S wires. For proper wire and connector repair, refer to Wiring Repairs in Engine Electrical.

Test Description

The number(s) below refer to the step numbers on the diagnostic table.

2. This test will indicate if the fault is still present, if the fault is not present operate the vehicle at different engine speeds and loads.
4. This test determines if the ECU is the cause of DTC 63.
10. This test will verify operation of the fuel control valves. If the pressure reading is fluctuating, this indicates proper operation of the fuel control valves. The fuel control valves may function at one operating condition and fail at another, operate the vehicle at varying engine speeds and loads to check for this condition.

DTC 63 HO2S Insufficient Activity Bank 2 Sensor 1

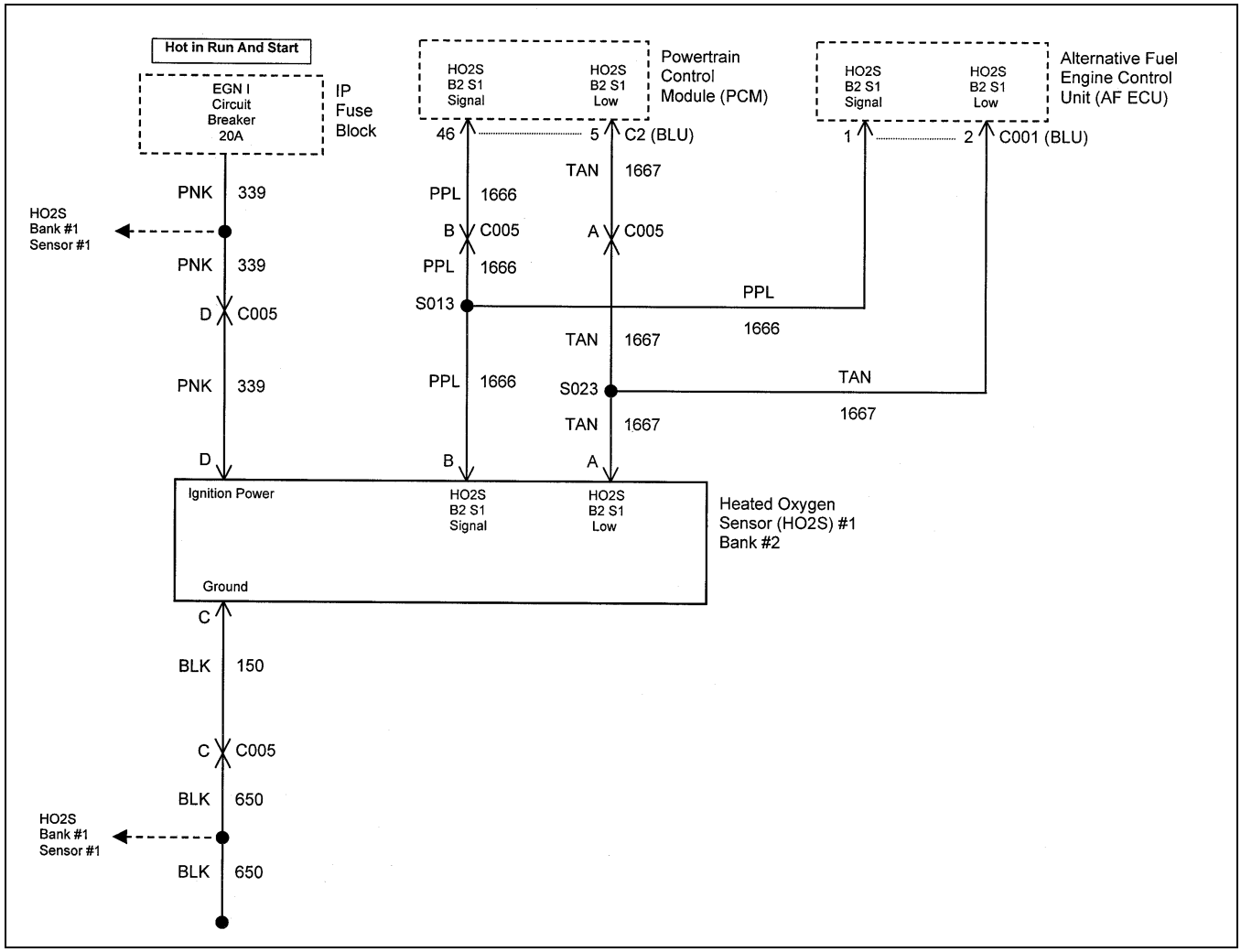
Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Install a scan tool. 2. Idle the engine at normal operating temperature. 3. Operate the engine above 1200 RPM for two minutes. 4. Observe the H02S reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage varying outside the specified range?	300 mV to 600 mV	Go to *Step 13*	Go to *Step 3*

Step	Action	Value(s)	Yes	No
3	1. Disconnect the HO2S (Bank 2, Sensor 1) sensor electrical connector. 2. Install a jumper between the HO2S (Bank 2, Sensor 1) harness high and low (PCM side) signal circuits. 3. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage less than the specified value?	200 mV	Go to *Step 7*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage less than the specified value?	200 mV	Go to *Step 14*	Go to *Step 5*
5	1. Remove the jumper wire. 2. Using a DVOM, measure the voltage between the bank 2 HO2S 1 high signal circuit and a known good ground. Is the voltage within the specified range?	375 mV to 525 mV	Go to *Step 6*	Go to *Step 8*
6	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 2 HO2S 1 signal low circuit between the PCM and the HO2S connector. 3. Check the bank 2 HO2S 1 low circuit for a short to ignition power or ground. Was a problem found?	—	Go to *Step 17*	Go to *Step 16*
7	1. Remove the jumper wire. 2. Using a DVOM, measure the voltage between the bank 2 HO2S 1 high signal circuit and a known good ground. Is the voltage within the specified range?	375 mV to 525 mV	Go to *Step 9*	Go to *Step 8*
8	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 2 HO2S 1 signal high circuit between the PCM and the HO2S connector. 3. Check the bank 2 HO2S 1 high circuit for a short to ignition power or ground. Was a problem found?	—	Go to *Step 17*	Go to *Step 16*

Step	Action	Value(s)	Yes	No
9	1. Check for a poor terminal connection at the bank 2 HO2S 1 connector. Check all connector circuit connections for loose terminal tension. 2. Install a test lamp between the bank 2 HO2S 1 heater high and low circuits, the test lamp should illuminate. Was a problem found?	—	Go to *Step 15*	Go to *Step 10*
10	1. Reconnect the HOS2 connector. 2. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 3. Start the engine. 4. Observe the pressure gauge in the secondary test port. Is the fuel pressure reading steady?	—	Go to *AF Fuel System Diagnosis*	Go to *Step 11*
11	1. Check for engine vacuum leakage. Repair any leaks that are found. 2. Check for exhaust system leakage upstream of the sensor. Repair any leaks that are found. Was a problem found and repaired?	—	Go to *Step 19*	Go to *Step 12*
12	Replace the bank 2 HO2S 1. Is the action complete?	—	Go to *Step 19*	—
13	The DTC is intermittent. Are there any Powertrain DTCs displayed that have not been diagnosed?	—	Go to the applicable Powertrain DTC table	Go to *Diagnostic Aids*
14	Check for a poor connection at the ECU. Was a problem found?	—	Go to *Step 17*	Go to *Step 15*
15	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 19*	—
16	Check for a faulty or loose connection at the PCM connector. Was a problem found?	—	Go to *Step 17*	Go to *Step 18*
17	Repair the circuit as necessary. Is the action complete?	—	Go to *Step 19*	—
18	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	Go to *Step 19*	—

Step	Action	Value(s)	Yes	No
19	1. Bring the engine up to normal operating temperature. 2. Run the engine above the specified value for at least 4 minutes. 3. Turn OFF the engine and the ignition for at least 10 seconds 4. Run the engine above the specified value for at least 4 minutes (second time). Did the MIL illuminate?	1500 RPM	Go to *Step 2*	System OK

DTC 64 HO2S Circuit Low Voltage Bank 2 Sensor 1



Circuit Description

The ECU supplies a voltage of about 0.45 volt between the HO2S High and HO2S Low circuits. The Heated Oxygen Sensor (HO2S Bank 2 Sensor 1) varies the voltage within the range of about 1.0 volt if the exhaust is rich, down to about 0.1 volt if the exhaust is lean.
The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F). DTC 64 determines if the HO2S sensor or the circuit is shorted to low by checking for an extended lean condition. This DTC is a type B DTC.

Conditions for Setting the DTC

- The ECT is greater than 70°C (160°F).
- The oxygen sensor has been warm for at least 120 seconds. The oxygen sensor is determined to be warm by the ECU if ECT is greater than 40°C (104°F) and the mass air flow is above 11 g/s for at least 120s.
- The ECU is in closed loop operation.
- The HO2S (Bank 2 Sensor 1) voltage is less than (0.02 volt) 20 mV.

Action Taken When the DTC Sets

The MIL will be turned on after 2 consecutive trips with test failures. The system will operate in Open Loop if any DTC of the second HO2S (Bank 1 Sensor 1) is set (DTC 42, 44 or 45).

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.

Check the following conditions:

- A heated oxygen sensor wire: A sensor pigtail may be mis-routed and contacting the exhaust manifold.
- An intermittent ground in the wire between the connector and the sensor.
- A poor ECU to the engine block ground.
- If the above check out okay, the problem is a faulty heated sensor.

Never solder the HO2S wires. For proper wire and connector repair, refer to *Wiring Repairs* in Engine Electrical.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

11. This step will determine if the fault is currently present.
12. This step will determine if the HO2S is shorted and the cause of the fault.
13. This step will determine if the AF ECU is the cause of the fault.
14. This test determines if the sensor wiring is the cause of the DTC 64.

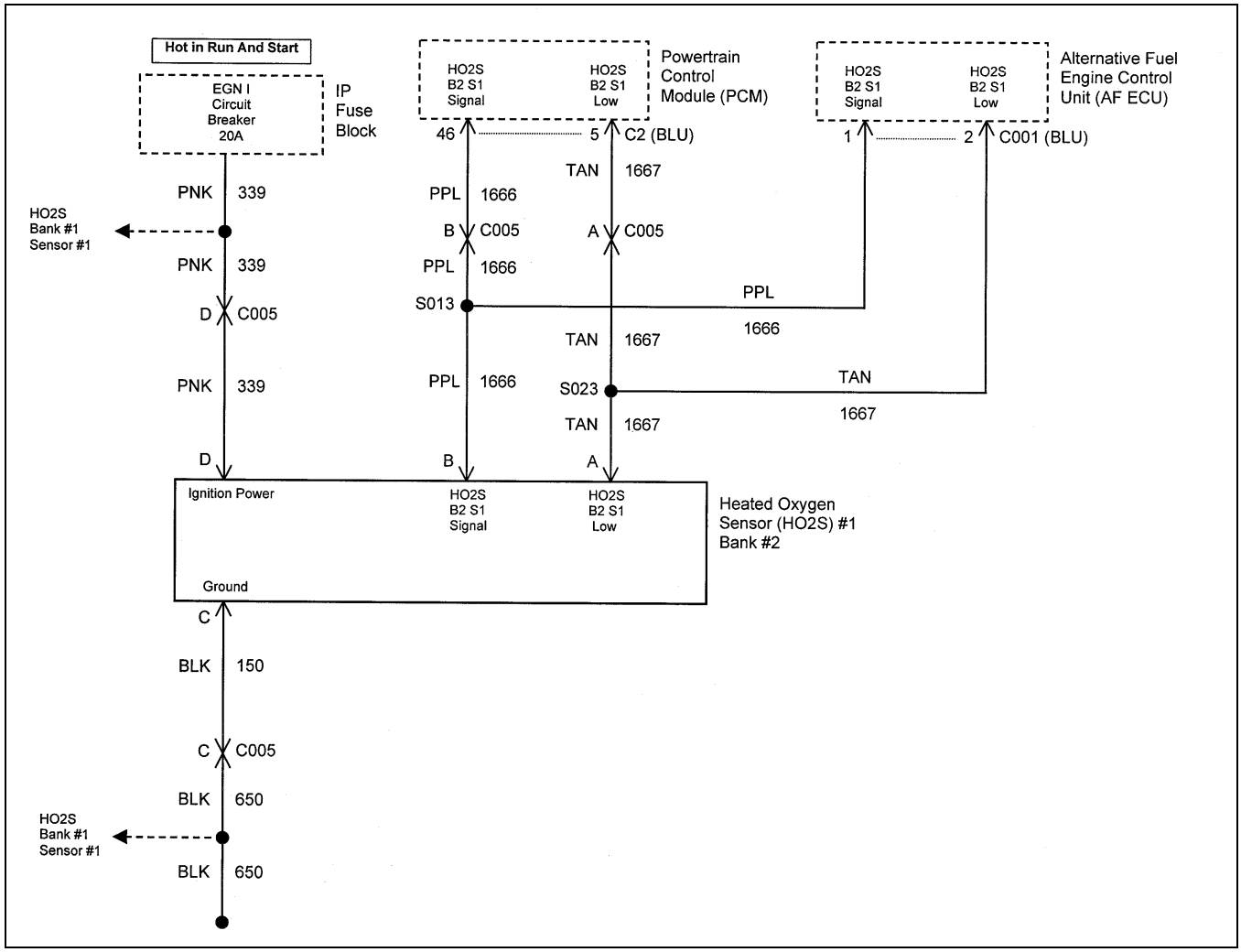
DTC 64 HO2S Circuit Low Voltage Bank 2 Sensor 1

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	***Go to* AF Powertrain OBD System Check**
2	1. Install a scan tool. 2. Idle the engine at normal operating temperature. 3. Operate the engine above 1200 RPM for two minutes. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage varying outside the specified range?	300 mV to 600 mV	Go to *Step 8*	Go to *Step 3*
3	1. Disconnect the HO2S (Bank 2, Sensor 1) sensor electrical connector. 2. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage is within the specified range?	350 mV to 550 mV	Go to *Step 6*	*Go to Step 4*
4	1. Turn the ignition OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage within the specified range?	350 mV to 550 mV	Go to *Step 9*	Go to *Step 5*

Step	Action	Value(s)	Yes	No
5	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 2 HO2S 1 signal high circuit between the PCM, ECU and the HO2S connector. 3. Check the bank 2 HO2S 1 high circuit for a short to voltage or ground. Was a problem found?	—	Go to *Step 12*	Go to *Step 11*
6	1. Check for a poor terminal connection at the bank 2 HO2S 1 connector. Check all circuits for loose terminal tension. 2. Install a test lamp between the bank 2 HO2S 1 heater high and low circuits, the test lamp should illuminate. Was a problem found?	—	Go to *Step 12*	Go to *Step 7*
7	Replace the bank 2 HO2S 1. Is the action complete?	—	Go to *Step 14*	—
8	The DTC is intermittent. Are there any Powertrain DTCs displayed that have not been diagnosed?	—	Go to the applicable Powertrain DTC table	Go to *Diagnostic Aids*
9	Check for a poor connection at the ECU. Was a problem found?	—	Go to *Step 12*	Go to *Step 10*
10	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 14*	—
11	Check for a faulty or loose connection at the PCM connector. Was a problem found?	—	Go to *Step 12*	Go to *Step 13*
12	Repair the circuit as necessary. Is the action complete?	—	Go to *Step 14*	—
13	Replace the PCM. **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	Go to *Step 14*	—

Step	Action	Value(s)	Yes	No
14	1. Bring the engine up to normal operating temperature. 2. Run the engine above the specified value for at least 4 minutes. 3. Turn OFF the engine and the ignition for at least 10 seconds. 4. Run the engine above the specified value for at least 4 minutes (second time). Did the MIL illuminate?	1500 RPM	Go to *Step 2*	System OK

DTC 65 HO2S Circuit High Voltage Bank 2 Sensor 1



Circuit Description

The ECU supplies a voltage of about 0.45 volt between the HO2S High and HO2S Low circuits. The Heated Oxygen Sensor (HO2S Bank 2 Sensor 1) varies the voltage within the range of about 1.0 (1000 mV) volt if the exhaust is rich, down to about 0.1 (100 mV) volt if the exhaust is lean.
The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F). DTC 65 determines if the HO2S sensor or the circuit is shorted to high by checking for an extended rich condition. This DTC is a type B DTC.

Conditions for Setting the DTC

- The engine is running at greater than 500 RPM.
- The ECT is greater than 70°C (160°F).
- The oxygen sensor has been warm for at least 120 seconds. The oxygen sensor is determined to be warm by the ECU if ECT is greater than 40°C (104°F) and the mass air flow is above 17 g/s for at least 120s.
- The ECU is in closed loop operation.
- The HO2S (Bank 2 Sensor 1) voltage is greater than 1.0 volt.

Action Taken When the DTC Sets

The MIL will be turned on after 2 consecutive trips with test failures. The system will operate in Open Loop if any DTC of the second HO2S (Bank 1 Sensor 1) is set (DTC 42,44 or 45).

Conditions for Clearing the MIL/DTC

The ECU turns the MIL off after 3 consecutive driving trips without a fault condition present. A DTC will clear if no fault conditions have been detected for 40 warm-up cycles (coolant temperature has risen 40°C (72°F) from the start-up coolant temperature and the engine coolant temperature exceeds 70°C (160°F) during that same ignition cycle) or the code clearing procedure has been used.

Diagnostic Aids

Always diagnose **ANY** PCM codes that are present before beginning this diagnostic procedure.
Check the following items:

- Fuel pressure - The ECU can compensate for small increases in fuel pressure. However, large increases in fuel pressure may set a DTC.
- Faulty Low Pressure Regulator.
- Faulty Fuel Control Solenoid (FCS).
- Vacuum leaks in the fuel control valve hoses.
- Faulty Regulator Control Valve (RCV).
- False rich indication due to silicon contamination of the HO2S. This will be accompanied by lean driveability conditions and a powdery white deposit on the sensor.
- Faulty HO2S (Bank 2 Sensor 1). If the HO2S (Bank 2 Sensor 1) is internally shorted, the HO2S (Bank 2 Sensor 1) voltage displayed will be over 1V. Try disconnecting the HO2S (Bank 2 Sensor 1); if the displayed voltage goes from over 1000 mV to around 450 mV, replace HO2S (Bank 2 Sensor 1).
- Never solder the HO2S wires.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

15. This step will determine if the fault is currently present.
16. This step will determine if the HO2S is shorted and the cause of the fault.
17. This step will determine if the AF ECU is the cause of the fault.
18. This test determines if the sensor wiring is the cause of the DTC 65.

DTC 65 HO2S Circuit High Voltage Bank 2 Sensor 1

Step	Action	Value(s)	Yes	No
1	Was the Alternative Fuels (AF) Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to *Step 2*	Go to *AF Powertrain OBD System Check*
2	1. Install a scan tool. 2. Idle the engine at normal operating temperature. 3. Operate the engine above 1200 RPM for two minutes. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage varying outside the specified range?	300 mV to 600 mV	Go to *Step 8*	Go to *Step 3*
3	1. Disconnect the HO2S (Bank 2, Sensor 1) sensor electrical connector. 2. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage is within the specified range?	350 mV to 550 mV	Go to *Step 6*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect ECU connector C001. 3. Turn the ignition ON. 4. Observe the H02S sensor reading on the scan tool. Does the scan tool indicate the bank 2 HO2S 1 voltage within the specified range?	350 mV to 550 mV	Go to *Step 9*	Go to *Step 5*

Step	Action	Value(s)	Yes	No
5	1. Disconnect the PCM connector. 2. Using a DVOM, check for continuity of the bank 2 HO2S 1 signal high circuit between the PCM, ECU and the HO2S connector. 3. Check the bank 2 HO2S 1 high circuit for a short to voltage or ground. 4. Check the bank 2 HO2S 1 low circuit for a short to voltage or ground. Was a problem found?	—	Go to *Step 12*	Go to *Step 11*
6	1. Check for a poor terminal connection at the bank 2 HO2S 1 connector. Check all circuits for loose terminal tension. 2. Install a test lamp between the bank 2 HO2S 1 heater high and low circuits, the test lamp should illuminate. Was a problem found?	—	Go to *Step 12*	Go to *Step 7*
7	Replace the bank 2 HO2S 1. Is the action complete?	—	*Go to Step 14*	—
8	The DTC is intermittent. Are there any Powertrain DTCs displayed that have not been diagnosed?	—	Go to the applicable Powertrain DTC table	Go to *Diagnostic Aids*
9	Check for a poor connection at the ECU. Was a problem found?	—	Go to *Step 12*	Go to *Step 10*
10	Replace the ECU. Refer to *ECU Replacement.* Is the action complete?	—	Go to *Step 14*	—
11	Check for a faulty or loose connection at the PCM connector. Was a problem found?	—	Go to *Step 12*	Go to *Step 13*
12	Repair the circuit as necessary. Is the action complete?	—	Go to *Step 14*	—
13	Replace the PCM **Important:** If the PCM is faulty, reprogram the PCM. Refer to PCM *Replacement/Programming*. The 7.4L LPG fuel system requires a unique PCM software calibration. Is the action complete?	—	Go to *Step 14*	—

Step	Action	Value(s)	Yes	No
14	1. Bring the engine up to normal operating temperature. 2. Run the engine above the specified value for at least 4 minutes. 3. Turn OFF the engine and the ignition for at least 10 seconds. 4. Run the engine above the specified value for at least 4 minutes (second time). Did the MIL illuminate?	1500 RPM	Go to *Step 2*	System OK

Symptom Diagnosis

Important Preliminary Checks

Checks	Action
Before Using This Section	Before using this section, you should have performed AF Powertrain On Board Diagnostic Check and determined that: 1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly. 2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL. Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks that may save valuable time.
Visual and Physical Checks	• Check all ECU and PCM system fuses. • Check the Control Module grounds for being clean, tight and in their proper location. • Check the vacuum hoses for splits, kinks and proper connections, as shown on the Vehicle Emission Control Information Label. • Check thoroughly for any type of leak or restriction. • Check for air leaks at all the mounting areas of the intake manifold sealing surfaces. • Check for proper installation of the mixer module assembly. • Check for air leaks at the mixer assembly. • Check the ignition wires for the following conditions: – Cracking – Hardness – Proper routing – Carbon tracking • Check the wiring for the following items: – Proper connections – Pinches – Cuts • The following symptom tables contain groups of possible causes for each symptom and cover several engines. The following symptom tables cover several engines. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first. In order to determine if a specific vehicle is using a particular system or component, refer to the Control Module Wiring Diagrams in the GM MD Service Manual for an application.
Symptom	1. Verify the customer complaint. 2. Locate the correct symptom table. 3. Check the items indicated under that symptom.

Intermittents

Checks	Action
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	• Refer to Important Preliminary Checks • Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	• Faulty electrical connections or wiring can cause most intermittent problems. • Check the suspected circuit for the following conditions: – Connectors poorly mated – Terminals not fully seated in the connector (backed out) – Terminals not properly formed or damaged – Terminal to wires poorly connected – Terminal tension insufficient. • Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension. • Checking for poor terminal to wire connections requires removing the terminal from the connector body in.
Road Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a *J 39200* connected to a suspected circuit or use a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no DTC(s): • A defective relay, Control Module driven solenoid, or a switch that can cause an electrical system interference. Normally, the problem will occur when the faulty component is operating. • The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. • The ignition secondary voltage shorted to a ground. • The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. • The Control Module grounds.
Loss of DTC Memory	1. In order to check for the loss of the DTC Memory, disconnect the Throttle Position (TP) sensor. 2. Idle the engine until the Malfunction Indicator Lamp illuminates. 3. The PCM and should store a Throttle Position DTC. 4. The Throttle Position DTC should remain in the memory when turning off the ignition. 5. If the Throttle Position DTC does not store and remain, the Control Module is faulty. 6. The ECU memory may be checked in the same manner by selecting a DTC and intentionally setting the fault
Additional Checks	Check for an open diode across the A/C compressor clutch and for other open diodes.

Hard Start

Checks	Action
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	• Refer to *Important Preliminary Checks*. • Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	• Check the Engine Coolant Temperature (ECT) sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to *DTC P0118 ECT Sensor Circuit High Voltage* or *DTC P1115 ECT Sensor CKT Intermittent High Voltage* in the GM MD Service Manual. • Check the Crankshaft Position Sensor (CKP). • Check the Mass Air Flow (MAF) sensor.
Fuel System Checks	**Important**: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. • Check the fuel pump relay for proper operation. The fuel pump relay circuit supplies a voltage signal to the AF system ECU and lock off valves. Refer to *Fuel Pump Circuit Diagnosis* in the GM MD Service Manual. • Verify proper operation of the low pressure lock-off solenoids. • Verify proper operation of the fuel control solenoid. • Verify proper operation of the ETC control solenoid. • Verify proper operation of the idle control solenoids. • Check for air intake system leakage between the mixer and the throttle body. • Check the fuel system pressures. Refer to the *AF Fuel System Diagnosis*. • Check mixer module assembly for proper installation and leakage.

Checks	Action
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. • Check for the proper ignition voltage output with *J 26792* or the equivalent. • Check the spark plugs for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Check for bare or shorted ignition wires. • Check for moisture in the distributor cap if applicable. • Check for loose ignition coil connections. **Important**: 1. If the engine starts but then immediately stalls, remove the (CKP) sensor. 2. Check for improper resistance or faulty connections. 3. Check the Crankshaft Position (CKP) sensor resistance and connections. Refer to *Enhanced Ignition System* in the GM MD Service Manual.
Engine Mechanical Checks	**Important:** The AF system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. • Check for the following: – Vacuum leaks – Improper valve timing – Low compression – Bent pushrods – Worn rocker arms – Broken or weak valve springs – Worn camshaft lobes. Ref • Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	• Check the exhaust system for a possible restriction: – Inspect the exhaust system for damaged or collapsed pipes – Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis* or *Exhaust System* in the GM MD Service Manual.
Additional Checks	• Verify the correct PCM software is installed.

Cuts Out, Misses

Checks	Action
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	• Refer to *Important Preliminary Checks*.

Ignition System Checks	• Start the engine.
	• Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water.
	• Check for proper ignition output voltage with spark tester J 26792.
	• Check for a cylinder misfire.
	• Remove the spark plugs in these cylinders and check for the following conditions:
	  • Insulation cracks
	  • Wear
	  • Improper gap
	  • Burned electrodes
	  • Heavy deposits
	  • Visually/Physically inspect the secondary ignition for the following:
	  • Ignition wires for arcing, cross-firing and proper routing
	  • Ignition coils for cracks or carbon tracking

Engine Mechanical Checks	• Perform a cylinder compression check.
	• Check the engine for the following:
	  – Improper valve timing
	  – Bent pushrods
	  – Worn rocker arms
	  – Worn camshaft lobes.
	  – Broken or weak valve springs.
	• Check the intake and exhaust manifold passages for casting flash.

Fuel System Checks	• Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to *AF Fuel System Diagnosis*. • Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). • EMI on the reference circuit can cause a missing condition. • Monitoring the engine RPM with a scan tool can detect an EMI. • A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. • If the problem exists, check the routing of the secondary wires and the ground circuit.

Hesitation, Sag, Stumble

Checks	Action
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition is usually most severe when trying to make the vehicle move, as from a stop sign. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to *Important Preliminary Checks*.
Fuel System Checks	• Check the fuel pressure. Refer to *AF Fuel System Diagnosis*. • Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. • Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. • Check the mixer module assembly for proper installation and leakage. • Verify proper operation of the regulator control valve.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly. • Check for the proper ignition voltage output with *J 26792* or the equivalent. • Check for faulty spark plug wires • Check for fouled spark plugs. • Check for an open ignition system ground. Refer *to Enhanced Ignition System* in the GM MD Service Manual.
Additional Check	• Check for Service Bulletins. • Check for manifold vacuum or air induction system leaks • Check the generator output voltage. • Check the EGR valve operation. Refer to *EGR System Diagnosis* in the GM MD Service Manual.

Backfire

Checks	Action
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	• Refer to *Important Preliminary Checks*.
Ignition System Checks	Note: LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. • Check for the proper ignition coil output voltage using the spark tester *J26792* or the equivalent. • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. **Note**: The vehicle may be equipped with low resistance plug wires, refer to MD service manual for proper plug wire resistance. • Check for deteriorated spark plug wire insulation. • Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Check the ignition system. Refer to *Ignition System Diagnosis* in the GM MD Service Manual.
Engine Mechanical Check	**Important:** The AF system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system. • Check the engine for the following: – Improper valve timing – Engine compression – Manifold vacuum leaks – Intake manifold gaskets – Sticking or leaking valves – Exhaust system leakage • Check the EGR operation for being open all the time. Refer to *EGR System Diagnosis* in the GM MD Service Manual. • Check the intake and exhaust system for casting flash or other restrictions.
Fuel System Checks	• Perform a fuel system diagnosis. Refer to *AF Fuel System Diagnosis*.
Additional Checks	• Proper PCM software calibrations • Check the EGR gasket for a faulty or loose fit. • Check the EGR valve operation for being open all the time. Refer to *EGR System Diagnosis* in the GM MD Service Manual.

Lack of Power, Sluggishness, or Sponginess

Checks	Action
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	• Refer to *Symptoms*. • Refer to the *Alternative Fuel (AF) Powertrain OBD System Check* • Search for service bulletins. • Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. *Do not compare the power output of the vehicle operating on LPG to a vehicle operating gasoline as the fuels do have different drive feel characteristics* • Remove the air filter and check for dirt or restriction. • Check the transmission shift pattern and the downshift operation.
Fuel System Checks	• Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to *AF Fuel System Diagnosis*. • Check for the proper ignition output voltage with the spark tester *J 26792* or the equivalent. • Check for proper installation of the mixer module assembly. • Check all air inlet ducts for condition and proper installation. • Check for fuel leaks between the LPR and the mixer. • Verify proper operation of the regulator control valve (RCV) • Verify that the LPG tank manual shut-off valve is fully open. • Verify that liquid fuel (not vapor) is being delivered to the LPR. • Verify that the correct PCM software is installed.
Sensor Checks	• Check the Heated Oxygen Sensor (HO2S) for contamination and performance. Refer to *Heated Oxygen Sensor* in the GM MD Service Manual. • Check for proper operation of the MAP sensor. • Check for proper operation of the ECT sensor. • Check EGR system for proper operation.
Exhaust System Checks	• Check the exhaust system for a possible restriction: – Inspect the exhaust system for damaged or collapsed pipes – Inspect the muffler for signs of heat distress or for possible internal failure. – Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis* or *Exhaust System* in the GM MD Service Manual.
Engine Mechanical Check	Check the engine for the following: • Engine compression • Valve timing • Improper or worn camshaft. Refer to Engine Mechanical in the GM MD Service Manual.

Checks	Action
Additional Check	• Check the Control Module grounds for being clean, tight, and in their proper locations. • Check for an Intermittent EGR problem. Refer to *EGR System Diagnosis* in the GM MD Service Manual. • Check the A/C operation. Refer to *A/C Compressor Clutch Control Diagnosis* in the GM MD Service Manual. • Check for proper Torque Converter Clutch (TCC) operation. • Check the generator output voltage. • If all procedures have been completed and no malfunction has been found, review and inspect the following items: • Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. • Check the scan tool data.

Poor Fuel Economy

Checks	Action
DEFINITION: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.	
Preliminary Checks	• Refer to *Important Preliminary Checks*. • Check the air cleaner element (filter) for dirt or being plugged. • Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections as shown on the Vehicle Emission Control Label. • Check the owner's driving habits for the following items: – Is the A/C ON full time (Defroster mode ON)? – Is there excessive idling or stop and go driving? – Are the tires at the correct air pressure? – Are excessively heavy loads being carried? – Is their often rapid acceleration? • Suggest to the owner to fill the fuel tank and to recheck the fuel economy. • Suggest to the driver to refer to Important Facts on Fuel Economy in the GM MD Owner's Manual.
Fuel System Checks	• Check the fuel pressure. Refer to *AF Fuel System Diagnosis*. • Check the fuel system for leakage
Sensor Checks	• Check the Engine Coolant Temperature (ECT) sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. If the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to *DTC P0118 ECT Sensor Circuit High Voltage* or *DTC P1115 ECT Sensor CKT Intermittent High Voltage* in the GM MD Service Manual. • Check the Mass Air Flow (MAF) sensor.
Ignition System Checks	• Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Check the ignition wires for the following items: – Cracking – Hardness – Proper connections
Cooling System Checks	• Check the engine coolant level. • Check the engine thermostat for always being open or for the wrong heat range. Refer to *Thermostat Diagnosis* in Engine Cooling in the GM MD Service Manual.

Checks	Action
Additional Check	• Check the transmission shift pattern. Refer to the Transmission Controls section in the GM MD Service Manual. • Check for Torque Converter Clutch (TCC) operation. Refer *to Torque Converter Clutch Solenoid* in Automatic Transmission in the GM MD Service Manual. • Check for proper calibration of the speedometer. • Check for dragging brakes.

Rough, Unstable, or Incorrect Idle, Stalling

Checks	Action
DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Check	• Refer to *Important Preliminary Checks*.

Sensor Checks	• Check for silicon contamination from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The Control Module will reduce the amount of fuel delivered to the engine causing a severe driveability problem.
	• Check the (Heated) Oxygen Sensor (HO2S) performance:
	  • Refer to *DTC 44 HO2S Circuit Low Voltage Bank 1 Sensor 1*.
	  • Refer to *DTC 45 HO2S Circuit High Voltage Bank 1 Sensor 1*.
	  • Refer to *DTC 42 HO2S Insufficient Activity Bank 1 Sensor 1*.
	  • Refer to *DTC 64 HO2S Circuit Low Voltage Bank 2 Sensor 1*.
	  • Refer to *DTC 65 HO2S Circuit High Voltage Bank 2 Sensor 1*.
	  • Refer to *DTC 63 HO2S Insufficient Activity Bank 2 Sensor 1*.
	• Check the Engine Coolant Temperature (ECT) sensor using the scan tool to compare the engine coolant temperature with the ambient air temperature on a cold engine. If the coolant temperature reading is more than 5° greater than or less than the ambient air temperature on a cold engine, check for a high resistance in the coolant sensor circuit or the sensor itself. Refer to *DTC P1115 ECT Sensor CKT Intermittent High Voltage* Diagnostic Aids or *DTC P0118 ECT Sensor Circuit High Voltage* Diagnostic Aids in the GM MD Service Manual.
	• Check the Manifold Absolute Pressure (MAP) sensor response and accuracy.

Fuel System Checks	• Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Verify proper operation of the idle control solenoid. • Verify proper operation of the fuel control valve solenoid. • Verify proper operation of the regulator control valve. • Perform a cylinder compression test. Refer to *Engine Mechanical* in the GM MD Service Manual. • Check for leaking fuel injectors. While the injectors are not used, they provide a possible vacuum leak point. • Verify that the injector fuel rail plugs are in place. • Check the fuel pressure. Refer to the *AF Fuel System Diagnosis*. • Check mixer module assembly for proper installation and connection.

Checks	Action
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester *J26792* or the equivalent. Refer to *Ignition System Diagnosis* in the GM MD Service Manual. • Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Blistered insulators – Heavy deposits • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. **Note**: The vehicle may be equipped with low resistance plug wires, refer to MD Service Manual for proper plug wire resistance.
Additional Checks	**Important:** The AF system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. • Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. • Check the Control Module grounds for being clean, tight, and in their proper locations. • Check the Automatic Transmission Fluid Pressure (TPF) manual valve indicator. Refer to Transmission Fluid Pressure Switch Assembly. • Check the scan tool to determine if the Control Module is receiving an A/C signal. Refer to *A/C Compressor Clutch Control* in the GM MD Service Manual. If a problem exists with the A/C ON, check the A/C system operation. • Check for EGR being ON while idling which will cause roughness, stalling, and hard starting. Refer to *EGR System Diagnosis* in the GM MD Service Manual. • Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality. • Check the A/C refrigerant pressure for being too high or for a faulty high pressure switch. • Check the Crankcase Ventilation Valve for proper operation by placing a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace the valve. Refer to *Crankcase Ventilation System* in the GM MD Service Manual

Checks	Action
Engine Mechanical Check	• Check the engine for the following: – Broken motor mounts – Improper valve timing – Low compression – Bent pushrods – Worn rocker arms – Broken or weak valve springs – Worn camshaft lobes

Surges/Chuggles

Checks	Action
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.	
Preliminary Checks	• Refer to *Important Preliminary Checks*. • Be sure the driver understands the Torque Converter Clutch operation. • Be sure the driver understands the A/C Compressor operation. • Use the scan tool to make sure the reading of the Vehicle Speed Sensor (VSS) matches the vehicle speedometer. This excludes vehicles with electronic transmissions where some variation between the VSS and the speedometer is normal.
Sensor Checks	Check the (Heated) Oxygen Sensor (HO2S) performance: • Refer to *DTC 44 HO2S Circuit Low Voltage Bank 1 Sensor 1*. • Refer to *DTC 45 HO2S Circuit High Voltage Bank 1 Sensor 1*. • Refer to *DTC 42 HO2S Insufficient Activity Bank 1 Sensor 1*. • Refer to *DTC 64 HO2S Circuit Low Voltage Bank 2 Sensor 1*. • Refer to *DTC 65 HO2S Circuit High Voltage Bank 2 Sensor 1*. • Refer to *DTC 63 HO2S Insufficient Activity Bank 2 Sensor 1*.
Fuel System Checks	• Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check the fuel pressure while the condition exists. Refer to *AF Fuel System Diagnosis.* • Verify proper regulator control valve operation. • Verify proper fuel control solenoid operation. • Verify that the LPG manual shut-off valve is fully open. • Check the in-line fuel filter for restrictions.
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. Refer to *Enhanced Ignition System* in the GM MD Service Manual. • Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits Check the Crankshaft Position (CKP) sensor. Refer to *DTC P0336 CKP Sensor Circuit Performance* in the GM MD Service Manual.

Checks	Action
Additional Check	• Check the Control Module grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • Check the vacuum hoses for kinks or leaks. Refer to the Vehicle Emission Control Information label on the top of the radiator. • Check for an Intermittent EGR problem. Refer to *EGR System Diagnosis* in the GM MD Service Manual. • Check for Torque Converter Clutch (TCC) operation.

REPAIR INSTRUCTIONS

PROPANE FUEL SYSTEM PRESSURE RELIEF

CAUTION: The propane fuel system operates at pressures up to 312 psi. To minimize the risk of fire and personal injury, relieve the propane fuel system pressure (where applicable) before servicing the propane fuel system components.

To relieve propane fuel system pressure:
1. Close the manual shut-off valve (MSV) on the propane fuel tank.
2. Start and run the vehicle until the engine stalls.
3. Turn the ignition switch OFF.

Important
- Residual vapor pressure will be present in the fuel system. Ensure the work area is well ventilated before disconnecting any fuel line.

PROPANE FUEL SYSTEM LEAK TEST

CAUTION: Never use an open flame of any type to check for propane fuel system leaks.

Always inspect the propane fuel system for leaks after performing service. Check for leaks at the fittings of the serviced or replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector.

PROPANE FUEL FILTER REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Disconnect the fuel inlet line from the filter.
4. Remove the nut retaining the filter clamp.
5. Unscrew the filter from the electric lock-off.

Installation Procedure

1. Coat the male pipe threads with a liquid thread sealant compound.
2. Install and tighten the filter into the lock-off assembly.
3. Install and secure the filter clamp and nut.
4. Connect the fuel inlet line to the filter and tighten.
5. Open manual shut-off valve.
6. Start the vehicle and leak check the propane fuel system at each serviced fitting.

LOW PRESSURE LOCK-OFF (LPL) REPLACEMENT (UNDERBODY)

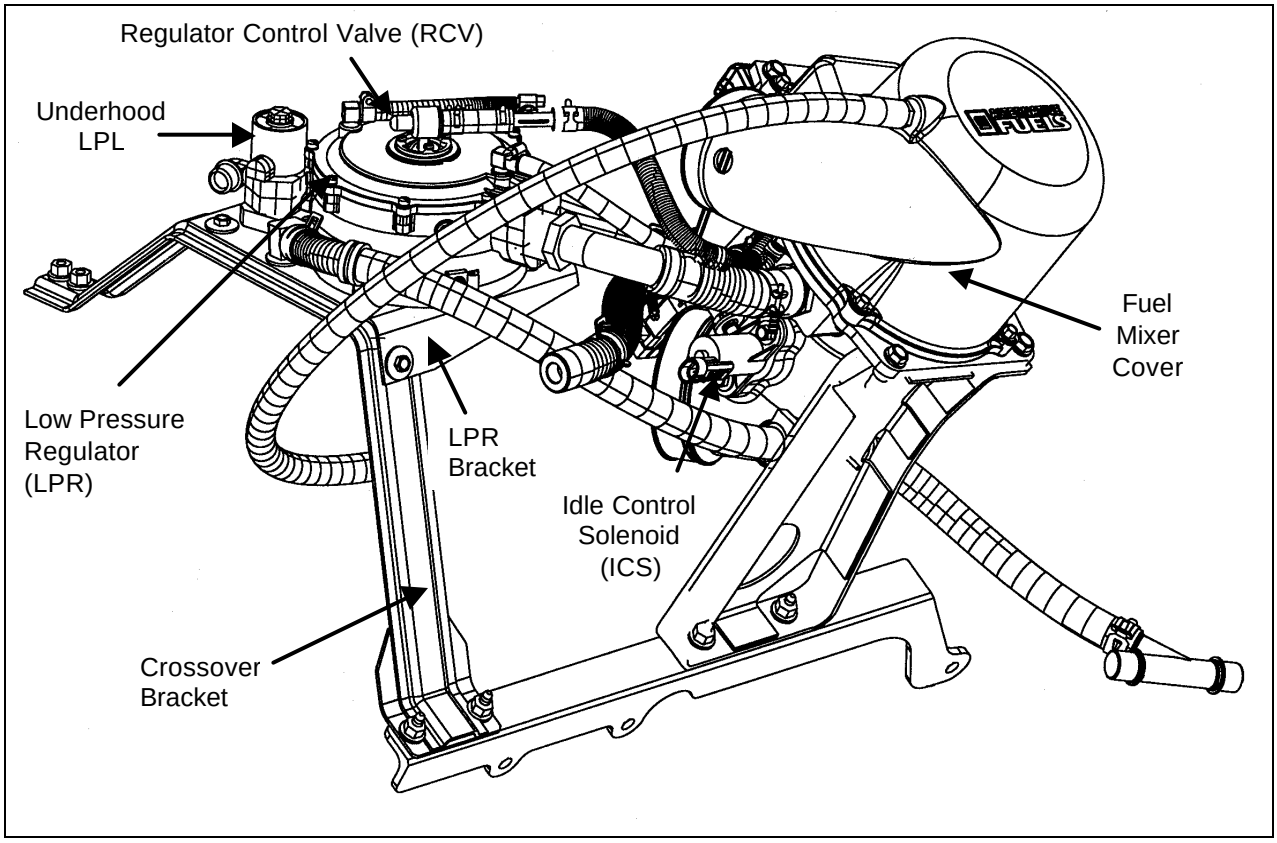
Removal Procedure

1. Relieve the propane fuel system pressure. Refer *to Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Remove the propane fuel filter. Refer to *Propane Fuel Filter Replacement.*
4. Disconnect the electric lock-off solenoid electrical connector.
5. Disconnect the fuel line.
6. Remove the two (2) electric lock-off solenoid mounting bolts.
7. Remove the lock-off from the bracket.
8. Remove the elbow fitting from the fuel outlet port.

Installation Procedure

Important
- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.

1. Install in reverse order of removal.
2. Tighten fuel fittings finger tight plus 1 to 2 turns.
3. Tighten fuel line fittings to 16-20 lb-ft.
4. Start the vehicle and leak check the propane fuel system and each serviced fitting.



LOW PRESSURE REGULATOR (LPR) REPLACEMENT

1. **Removal Procedure**

2. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
3. Disconnect the negative battery cable.
4. Drain the radiator.
5. Remove the air intake duct.
6. Loosen the hose clamp at the MAF sensor.
7. Disconnect the MAF sensor electrical connector.
8. Remove the engine air cleaner / MAF sensor assembly.
9. Disconnect the LPL electrical connector.
10. Disconnect the LPG fuel line from the LPR inlet fitting.
11. Disconnect the ICS fuel line from the LPR.
12. Remove the two (2) LPR to LPR bracket bolts.
13. Remove the three (3) LPR bracket to crossover bracket bolts.
14. Remove the one (1) LPR support bracket bolt from the intake manifold.
15. Remove the two (2) LPL mounting bolts.
16. Disconnect the three (3) vacuum hoses from the top of the LPR.
17. Disconnect the supply and return coolant lines from the LPR.
18. Disconnect the fuel vapor hose from the LPR outlet fitting.
19. Remove the LPR and LPL assembly.

Disassembly Procedure

1. Remove the LPL from the LPR.
2. Remove the RCV from the LPR.
3. Remove all fittings from the LPR.

Assembly Procedure

Important
- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.

1. Install all fittings to the LPR. Tighten the fittings finger tight plus 1 to 2 turns.
2. Install the RCV to the LPR. Tighten the RCV finger tight plus 1 to 2 turns.
3. Install the LPL to the LPR. Tighten the LPL finger tight plus 1 to 2 turns and place the LPL in the correct position.

Installation Procedure

Important
- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.

1. Install in reverse order of removal.
2. Tighten fuel line fitting to 16-20 lb-ft.
3. Start the vehicle and leak check the propane fuel system at each serviced fitting.

LOW PRESSURE LOCK-OFF (LPL) REPLACEMENT (UNDERHOOD)

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Remove the air intake duct.
4. Loosen the hose clamp at the MAF sensor.
5. Disconnect the MAF sensor electrical connector.
6. Remove the engine air cleaner / MAF sensor assembly.
7. Disconnect the LPL electrical connector.
8. Disconnect the LPG fuel line from the LPR inlet fitting.
9. Disconnect the ICS fuel line from the LPR.
10. Remove the two (2) LPR to LPR bracket bolts.
11. Remove the three (3) LPR bracket to crossover bracket bolts.
12. Remove the one (1) LPR support bracket bolt from the intake manifold.
13. Remove the two (2) LPL mounting bolts.
14. Unscrew the LPL from the LPR.

Installation Procedure

Important

- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.

1. Apply pipe thread sealant to the LPR inlet fitting.
2. Install the LPL to the LPR. Tighten the LPL finger tight plus 1 to 2 turns and place the LPL in the correct position.
3. Install in reverse order of removal.
4. Tighten the fuel line fitting to 16-20 lb-ft.
5. Start the vehicle and leak check the propane fuel system at each serviced fitting.

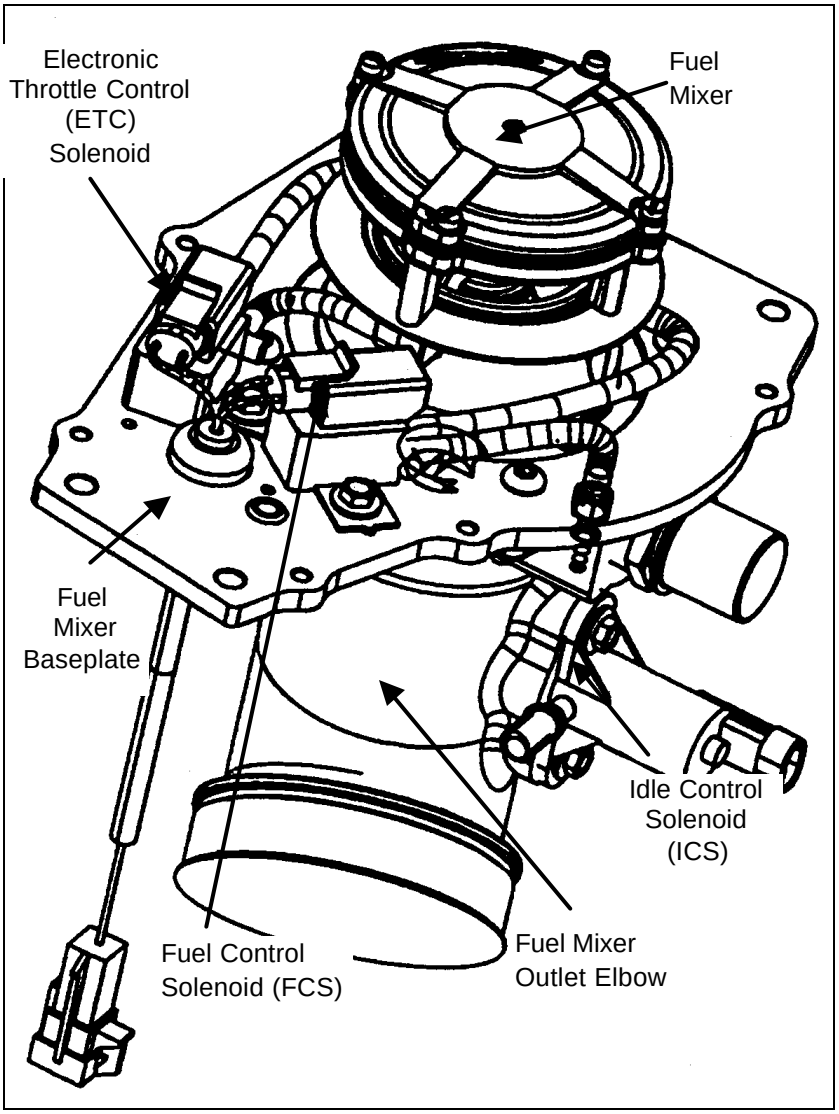
FUEL MIXER COVER REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Disconnect the IAT sensor electrical connector.
4. Disconnect the PCV breather hose from the fuel mixer cover.
5. Loosen the hose clamp at the fuel mixer cover inlet.
6. Remove the six (6) fuel mixer cover bolts and the cover.
7. Remove the IAT grommet from the fuel mixer cover.

Installation Procedure

1. Install in reverse order of removal.



ELECTRONIC THROTTLE CONTROL (ETC) SOLENOID REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Remove the fuel mixer cover. Refer to *Fuel Mixer Cover Replacement.*
4. Disconnect the ETC solenoid electrical connector.
5. Disconnect the two (2) vacuum hoses from the ETC solenoid.
6. Remove the ETC solenoid mounting bolt and the solenoid.

Installation Procedure

1. Install in reverse order of removal.

FUEL CONTROL SOLENOID (FCS) REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Remove the fuel mixer cover. Refer to *Fuel Mixer Cover Replacement.*
4. Disconnect the FCS solenoid electrical connector.
5. Disconnect the two (2) vacuum hoses from the FCS solenoid.
6. Remove the FCS solenoid mounting bolt and the solenoid.

Installation Procedure

1. Install in reverse order of removal.

IDLE CONTROL SOLENOID (ICS) REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Disconnect the ICS electrical connector.
4. Disconnect the ICS fuel hose from the LPR.
5. Remove the two(2) ICS solenoid mounting bolts and the solenoid.
6. Disconnect the fuel line from the ICS.

Installation Procedure

1. Install in reverse order of removal.

REGULATOR CONTROL VALVE (RCV) REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Disconnect the vacuum hose from the regulator control valve (RCV).
4. Unscrew the RCV from the LPR.

Installation Procedure

Important
- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.

1. Apply liquid pipe thread sealant to the RCV threads.
2. Install in reverse order of removal.

FUEL MIXER REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Remove the fuel mixer plate. Refer to *Fuel Mixer Plate Replacement.*
4. Disconnect the three (3) vacuum hoses from the mixer.
5. Remove the ETC solenoid mounting bolt replacement.
6. Remove the six (6) mixer mounting screws.
7. Remove the mixer.
8. Remove the mixer O-ring.
9. Remove the four (4) outer baseplate to bracket mounting bolts.
10. Loosen the four (4) baseplate to elbow screws approximately ½".

Installation Procedure

1. Install the mixer and the six (6) mounting screws.
2. Install the O-ring over the mixer and position between the outlet elbow and the baseplate.
3. Tighten the four (4) baseplate to elbow screws.
4. Install the four (4) outer baseplate to bracket mounting bolts.
5. Install the ETC solenoid bolts.
6. Connect the three (3) vacuum hoses to the mixer.
7. Install the fuel mixer cover. Refer to *Fuel Mixer Cover.*
8. Connect the negative battery cable.

FUEL MIXER OUTLET ELBOW REPLACEMENT

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to *Propane Fuel System Pressure Relief.*
2. Disconnect the negative battery cable.
3. Remove the fuel mixer plate. Refer to *Fuel Mixer Plate Replacement.*
4. Remove the fuel mixer. Refer to *Fuel Mixer Replacement.*
5. Remove the idle control solenoid (ICS). Refer to *Idle Control Solenoid (ICS) Replacement.*
6. Loosen the fuel vapor hose clamp at the elbow inlet fitting.
7. Loosen the throttle body hose clamp at the elbow.
8. Remove the fuel mixer elbow.

Installation Procedure

Important

- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.

1. Install in reverse order of removal.
2. Start the vehicle and check the propane fuel system at each serviced fitting.

ENGINE CONTROL UNIT (ECU) REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the ECU from the adapter bracket.
3. Disconnect the ECU electrical connectors.

Installation Procedure

1. Connect the ECU electrical connectors.
2. Install the ECU in the adapter bracket.
3. Connect the negative battery cable.

PROPANE FUEL SYSTEM INSPECTION

Inspect the propane fuel system hoses and vacuum lines for cracks, wear or other damage. Replace if necessary. Inspect the propane fuel system brackets for cracks, deformation or other damage. Replace if necessary. Inspect all fasteners and service as necessary.

TECHNICAL SPECIFICATIONS

Electric Lock-off Solenoid

Working pressures ..... Maximum 312 PSI
Nominal Operating Voltage ..... 12 - 16 volts DC nominal
Coil impedance. ..... 6.2-10 Ohms
Working Temperature ..... -40° to +250° F.
Typical Operation at -40° F.
- Maximum Voltage required to open Main Valve ..... 5.5 volts DC
- Nominal Draw ..... .75 amps
- Maximum Coil Amperage ..... 1 Amp

LIQUID PETROLEUM GAS

(Commercial)		Propane	Butane
Boiling point (°F) @ 30" Hg		-44 °	32 °
Specific gravity of air @ 60°F + 30" Hg		1.52	2.00
Specific gravity of water @ 60°F + 30" Hg		0.51	0.58
Weight per gallon @ 60°F		4.24#	4.85#
BTU per gallon (vaporized)		91,500	102,600
BTU per pound (vaporized)		21,560	21,180
Air-Fuel Ratio	By Volume	23 to 1	30 to 1
Best Power	By Weight	14.8 to 1	14.3 to 1
Vapor Pressure	Lbs./Sq. In.	Propane	Butane
	-10°F	20#	---
	0°F	28#	---
	10°F	45#	---
	32°F	60#	---
	60°F	100#	12#
	80°F	130#	22.5#
	100°F	190#	37#
	120°F	240#	55#

	Propane	Butane
Octane number (RON only)	125	91
Octane number as it relates to gasoline(approx.)	98	---
Critical compression ratios	12:1	6.4:1
Best compression ratio - range	9.5:1 - 10.5:1	---

	Propane	Gasoline
Weight per gallon @ 60°F	4.24#	6.3#
BTU per gallon (vaporized)	91,500	123,000
BTU per pound (vaporized)	21,560	20,500

PRESSURE CONVERSION CHART

MULTIPLY → TO OBTAIN ↓	Inches of Water Column	Ounces Per Square Inch	Inches of Mercury Column	Pounds Per Square Inch
Inches of Water Column	By ↓	1.731	13.6	27.7
Ounces Per Square Inch	.578	↑ By ↓	7.85	16
Inches of Mercury Column	0.0736	0.128	↑ By ↓	2.04
Pounds Per Square Inch	0.0361	.0625	0.491	↑ By